55.16/2:984

PENNSYLVANIA STATE UNIVERSITY
APR 13 1983
DOCUMENTS COLLECTION

The Federal Plan for Meteorological Services and Supporting Research

FISCAL YEAR 1984

FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES
AND SUPPORTING RESEARCH

FCM P1-1983

U.S. DEPARTMENT OF COMMERCE/National Oceanic and Atmospheric Administration

THE FEDERAL COMMITTEE FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH
(FCMSSR)

DR. JOHN V. BYRNE, Chairman
Department of Commerce

DR. T. B. KINNEY, JR.
Department of Agriculture

MS. EDITH W. MARTIN
Department of Defense

MR. DAVID SLADE
Department of Energy

VACANT
Environmental Protection Agency

MR. JOHN R. BRINKERHOFF
Federal Emergency Management Agency

MR. LEWIS T. MOORE
Department of Interior

DR. BURTON I. EDELSON
National Aeronautics and Space
Administration

DR. FRANCIS S. JOHNSON
National Science Foundation

DR. ROBERT F. ABBEY, JR.
U. S. Nuclear Regulatory Commission

MS. VIVIAN RIVERA
Office of Management and Budget

MR. S. AHMED MEER
Department of State

MR. NEAL A. BLAKE
Federal Aviation Administration
Department of Transportation

MR. WILLIAM S. BARNEY
Federal Coordinator
Department of Commerce

ALONZO SMITH, JR., Executive Secretary
Office of the Federal Coordinator
Department of Commerce

THE INTERDEPARTMENTAL COMMITTEE FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH
(ICMSSR)

WILLIAM S. BARNEY, Chairman
Federal Coordinator
Department of Commerce

DR. T. B. KINNEY, JR.
Department of Agriculture

DR. ELBERT W. FRIDAY
National Weather Service
Department of Commerce

COLONEL PAUL D. TRY, USAF
Department of Defense

DR. HARRY MOSES
Department of Energy

MR. WILLIAM H. KEITH
Environmental Protection Agency

MR. JAMES W. KERR
Federal Emergency Management Agency

MR. LEWIS T. MOORE
Department of Interior

DR. SHELBY TILFORD
National Aeronautics and Space
Administration

DR. RICHARD S. GREENFIELD
National Science Foundation

MR. JAMES C. MCLEAN
National Transportation Safety Board

MR. EARL H. MARKEE, JR.
U. S. Nuclear Regulatory Commission

MS. VIVIAN RIVERA
Office of Management and Budget

MR. JAMES C. DZIUK
Federal Aviation Administration
Department of Transportation

MR. RICHARD HAYES
U. S. Coast Guard
Department of Transportation

ALONZO SMITH, JR., Executive Secretary
Office of the Federal Coordinator
Department of Commerce

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

The Federal Plan for Meteorological Services And Supporting Research

FISCAL YEAR 1984

MARCH 1983
WASHINGTON, D.C.

U. S. Depository Copy

Digitized by the Internet Archive
in 2012 with funding from
LYRASIS Members and Sloan Foundation

http://archive.org/details/federxx00unit

PREFACE

This Federal Plan is the nineteenth in a series of annual plans developed by the Office of the Federal Coordinator for Meteorological Services and Supporting Research. This Plan focuses on the measures being taken to protect weather-sensitive activities. Pursuant to Section 304, Public Law 87-843, it is published to provide the Congress and the Executive Branch with a coordinated, overall plan for Government meteorological services and for those research and development programs that directly support and improve meteorological services. The Plan covers the programs of all agencies for FY 1983 and FY 1984. Much of the FY 1984 activity is aimed at strengthening the basic meteorological system through advanced weather radar, weather satellites, larger and faster computers, improved weather reconnaissance system, better forecast models of the ocean and atmosphere, and preparedness of the public to respond to warnings.

Historically, the Federal Plan has provided a description of the various agency plans for improving these services. These features will continue in this issue of the Plan. Additionally, in response to growing interest in the hurricane (and typhoon) forecast and warning service, the first section of the Plan is devoted to that subject.

The second section of this Plan highlights interagency cooperation that is essential to meet the needs for meteorological services. Section 3 contains a discussion of resource information and analysis. All fiscal data are current as of the end of January 1983. A special analysis of the National Climate Program is provided in Section 4. In Section 5, a description of the World Weather Program has been added. The appendices contain a compilation of agencies' weather activities and a list of acronyms.

The principal work of coordinating weather activities and of preparing and maintaining the Federal Plan is performed by the interagency committees shown on the inside front cover. These committees and their subcommittees conduct systematic, continuous reviews of basic and specialized meteorological requirements, services, and supporting research according to guidelines set forth in the Office of Management and Budget Circular A-62.

William S. Barney

William S. Barney
Federal Coordinator for
Meteorological Services and
Supporting Research

THE FEDERAL PLAN FOR METEOROLOGICAL SERVICES
AND SUPPORTING RESEARCH
FY 1984

TABLE OF CONTENTS

Page

PREFACE i

APPENDICES v

LIST OF TABLES vi

LIST OF FIGURES vi

Section 1. THE ROLE OF AERIAL RECONNAISSANCE IN HURRICANE FORECASTING 1-1

Section 2. FEDERAL COORDINATION AND PLANNING 2-1

Mission and Staffing of the Office of the Federal Coordinator for Meteorology 2-1

Specific Coordination of Multiagency Programs . . . 2-2

- Next Generation Weather Radar 2-3
- Automated Surface Observations 2-4
- Automated Aircraft Reporting System 2-5
- Improved Weather Reconnaissance System 2-7
- Meteorological Planning for Emergencies . . . 2-8
- Automated Weather Information Systems 2-8
- Improving Forecast of Icing Conditions for Aviation 2-9
- Long-term Federal Plan 2-9

Page

Coordination of Publications and Planning Activities 2-10

- o Federal Coordination of Meteorological Publications 2-10
- o Review of the Federal Committee Structure. . . 2-11
- o Procedural Issues. 2-14

Section 3. RESOURCE INFORMATION AND ANALYSIS 3-1

Agency Obligations for Meteorological Operations and Supporting Research. 3-1

Agency Operational Costs by Function. 3-6

Agency Supporting Research Costs by Function. . . . 3-8

Meteorological Operations and Supporting Research by Service 3-8

Agency Personnel Engaged in Weather Operations. 3-12

Interagency Fund Transfers. 3-14

Locations by Observing Type 3-16

Section 4. NATIONAL CLIMATE PROGRAM. 4-1

The Base Program 4-1

Cross-cut Review of the National Climate Program, FY 1984 Budget 4-2

Section 5. WORLD WEATHER PROGRAM 5-1

Goals and Organization of the World Weather Program 5-1

The World Weather Watch 5-2

Global Atmospheric Research Program 5-6

Other International Cooperative Programs. 5-10

APPENDICES

Page

A. COMPILATION OF STATEMENTS ON WEATHER PROGRAMS SUBMITTED TO THE OFFICE OF THE FEDERAL COORDINATOR BY THE AGENCIES

Department of Agriculture A-1

Department of Commerce
  National Oceanic and Atmospheric Administration . . . A-3

  o National Weather Service A-3

  o National Environmental Satellite, Data and Information Service A-17

  o Office of Oceanic and Atmospheric Research Environmental Research Laboratories A-32

Department of Defense A-36

  o United States Army A-36

  o United States Navy A-44

  o United States Air Force A-51

Department of Energy A-62

Department of Interior A-62

Department of State A-62

Department of Transportation A-63

  o Federal Aviation Administration A-63

  o U.S. Coast Guard A-67

Environmental Protection Agency A-68

Federal Emergency Management Agency A-69

National Aeronautics and Space Administration A-69

Nuclear Regulatory Commission A-72

B. ACRONYMS AND ABBREVIATIONS B-1

LIST OF TABLES

Page

3.1 Meteorological Operations and Supporting Research, by Agency 3-3

3.2 Agency Operational Costs, by Function 3-7

3.3 Agency Supporting Research Costs, by Function 3-9

3.4 Agency Operational Costs, by Service 3-10

3.5 Agency Supporting Research Costs, by Service 3-11

3.6 Agency Personnel Engaged in Weather Operations, by Function 3-13

3.7 Interagency Fund Transfers for Meteorological Operations and Supporting Research, FY 1983 3-15

3.8 Locations by Observation Function, FY 1983 and FY 1984 . 3-17

4.1 Climate FY 1984 Budget Requests by Agency 4-4

4.2 Climate FY 1984 Budget Requests by Subprograms and Agency 4-5

A.1 Projected Satellite Launch Schedule A-22

LIST OF FIGURES

1.1 Losses from Hurricanes in the United States 1-2

1.2 Major Landfalling United States Hurricanes, 1941-1980 . 1-4

1.3 High-density, High-accuracy Data Obtained by NOAA Research Aircraft 1-8

1.4 Schematic of Data Link, NOAA P-3 Aircraft to Satellite to National Hurricane Center 1-10

1.5 Sample of Data Transmitted by NOAA Research Aircraft . . 1-12

2.1 Structure of Federal Coordinating Committees 2-12

A.1 NWS Field Structure for Technical Operations A-6

A.2 Weather Service Activities A-6

A.3 Levels of Weather Service Functions A-8

A.4 Weather Service Interdependencies A-8

A.5 AFOS Communications - Regional Loops A-14

SECTION 1

THE ROLE OF AERIAL RECONNAISSANCE IN HURRICANE FORECASTING

Robert C. Sheets*

Introduction

Prior to July of 1943, the inside view of a hurricane was restricted to the unfortunate mariner who failed to escape its path or the coastal resident who stood his ground through choice or ignorance. The first to fly into the vortex of a hurricane was Joseph B. Duckworth, a veteran pilot of the scheduled airlines, who was at the time (July 1943) a Colonel in the Army Air Corps Reserve, in command of the Instrument Flying Instructors School at Bryan, Texas. It was one of those rare combinations of circumstances by which the man with the necessary skill, experience, daring, and inclination happened to be at the right place at the right time. With a full appreciation of the danger, he flew a single-engine airplane deliberately into the hurricane and proceeded on a direct heading into the calm center, looked around, and flew back to Bryan. His heroic act presaged a long and continuing role of aerial reconnaissance in the detection, monitoring and prediction of hurricanes.

Aerial reconnaissance has had a changing role. Emphasis was first placed on locating and tracking the "eye" of a well developed hurricane while it was still 300 to 600 miles offshore; this assured an early warning time for coastal areas that were in danger of being hit by the storm. The increasing range of aircraft allowed an added emphasis to be placed on early detection of the storm; this improved predictions of the track of the storm and increased the warning time. Early detection or verification was achieved by "search" aircraft following a particular fixed or synoptic path over the ocean area of interest. The search was initiated by ship reports or by meteorological conditions that suggested the existence or formation of a hurricane. With advances in aircraft performance, navigation systems, and meteorological sensors, it was then possible to obtain data that provide a detailed description of the hurricane dynamics and structure. This detailed description holds the prospect of greatly improved forecasts of the hurricane intensity and movement. As satellite technology improved, satellites became the primary means of detection, and the use of aircraft reconnaissance for detection purposes was abandoned. Each change in emphasis has increased our realization of the basic objective of weather services -- the improved prediction of the intensity and location of hurricanes at landfall.

The very nature of the hurricane event, i.e., the threat of severe and broad-scale consequences together with a relatively low frequency of its occurrence, suggests the need for a cooperative effort among Federal agencies. Cooperation has been accomplished each year since 1946 through an interdepartmental hurricane conference. The conference brings together cognizant agencies to reach agreement on items of mutual concern related to hurricane warning services. The Office of the Federal Coordinator for Meteorological Services and Supporting Research documents these agreements in a National Hurricane Operations Plan published annually since 1962.

---

*This is an invited article. Dr. Sheets is a Hurricane Specialist at the National Hurricane Center (NOAA), Miami, Florida.

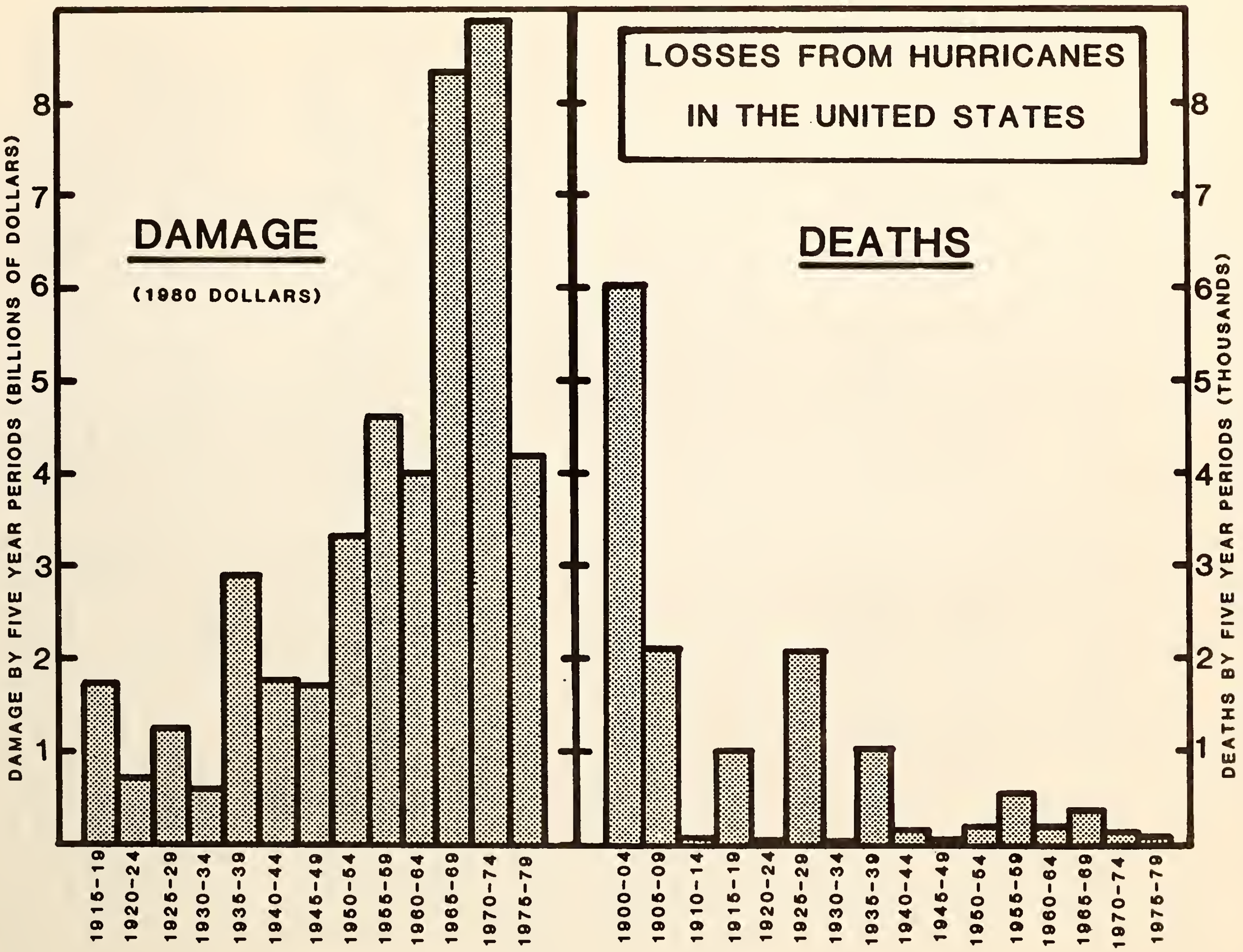


Figure 1.1. Losses From Hurricanes in the United States

Significance of Hurricane Forecasting

Tropical cyclones (hurricanes/typhoons) cause death and destruction in catastrophic proportions around the tropical and subtropical regions of the world each year. The rate of destruction increased dramatically worldwide in recent years with occasional large loss of life (Sen, 1979). Figure 1.1 shows damage and loss-of-life statistics for the continental United States by five-year periods, beginning in the early 1900s and extending through 1979. Damage values have been adjusted with the 1980 dollar as the base. Figure 1.2 shows tracks of major hurricanes striking the U. S. coast from 1941 through 1981 (Hebert and Taylor, 1983).

The escalating trend of direct economic losses from hurricane strikes during recent years is quite evident in Figure 1.1. The one exception is the period from 1975 through 1979 when tropical storms affecting the U.S. coasts were infrequent. Even with this lull in activity, average losses during the past 15 years have been over $1.4 billion per year. In contrast to other regions of the world, the United States has been quite fortunate because the loss of life from hurricanes has shown a steady decrease during this century. Despite this decrease, the American Meteorological Society Executive Committee in 1976 expressed concern that this trend may not continue and warns that a future hurricane disaster could occur which would equal or surpass the Galveston tragedy of 1900 when 6,000 people died. This concern is primarily based upon the following factors:

- Large and increasing population concentrations in hurricane-prone coastal regions;
- Nonexistence, or poor enforcement, of building safety codes;
- Inadequacy of evacuation routes or places of refuge;
- Hurricane forecasting accuracy limitations, particularly those related to intensity changes and storm movement; and
- A complacent public.

These factors are interrelated in creating a potential for disaster. Uncertainties of storm motion and intensity, compounded by problems of evacuation and storm preparation, generally result in overwarnings to protect life. These uncertainties lead to decreased accuracy of forecasts regarding the populated regions that may be hit by the storm. Consequently, the number of coastal residents who are alerted is greater than the number who would need to be alerted if the forecasts could be made more accurate. Such overwarning has a considerable economic and psychological impact on the public.

A study by Neumann (1975) shows that preparedness and loss of production costs for a typical 350-mile coastal hurricane warning zone along the Gulf of Mexico averages more than $42 million (1980 dollars, recently adjusted) with two-thirds of the area being overwarned. If it is assumed that this cost is proportional to the population density and adjusted to 1980 populations (an increase of about 17%), the cost becomes $49 million. On the average, two coastal hurricanes influence the United States each year; therefore, the United States spends an average of $65.3 million per year on hurricane preparedness due to overwarnings.

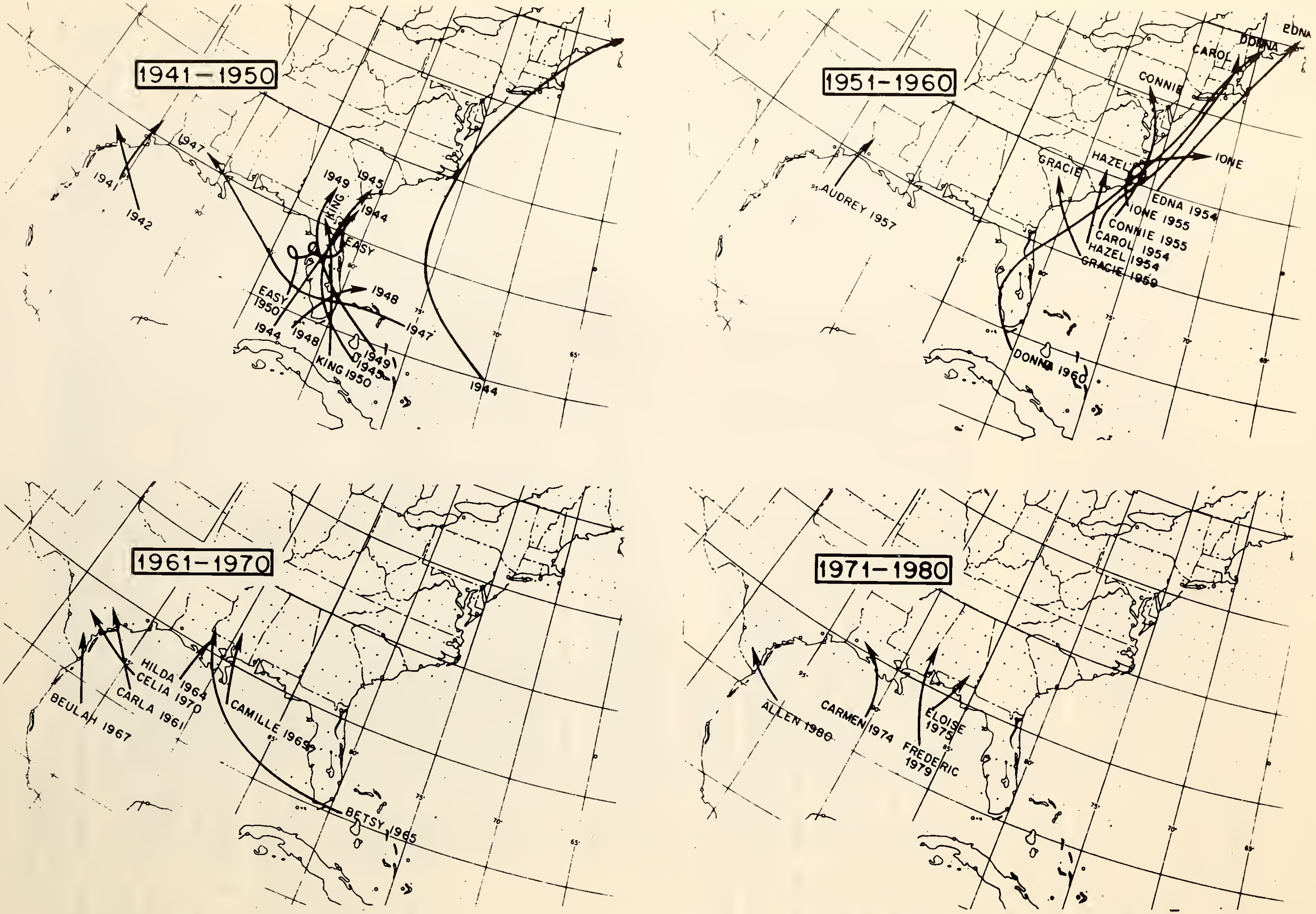


Figure 1.2. Major Landfalling United States Hurricanes, 1941-1980

Recent census reports and evacuation studies confirm the potential for disaster should a major tropical storm strike the coastal region of the United States. The 1980 census showed a general shift in population to the sunbelt with a large number of these people moving to coastal counties. For instance, the coastal county population of Florida was 3.9 million in 1960, 5.4 million in 1970, and 7.7 million in 1980. This represents an increase of 41 percent from 1960 to 1970 and 42 percent from 1970 to 1980 or nearly a doubling of the population in these hurricane prone areas during the past 20 years! Fortunately, Florida has had very few hurricane strikes during the period. This is in contrast to storm occurrences during the 1940's (Figure 1.2). There is no reason to believe that such frequencies will not return.

The Hurricane Forecast and Warning Service

Hurricane forecast and warning services differ in important ways from other forecast services. Unlike the general public forecast services, it is not a routine daily service; the full hurricane service is triggered by the detection of a tropical storm or a precursor cyclonic development. Unlike the tornado and severe thunderstorm forecast and warning services (which deal with events of relatively short duration), hurricane forecast services may continue for many days. Once triggered, the hurricane service provides a series of descriptions and predictions until the storm has died out. Frequently, there are multiple storms active at the same time and, therefore, the services with respect to each must proceed in parallel. Because of the magnitude of potential consequences, public attention is focused on the landfall aspects of these services. However, the offshore services that are provided are critical to marine interests in general, to the naval and air operations of the Department of Defense (DOD), to civil international trade, and to offshore oil operations.

The total hurricane weather services consist of three parts: (1) detection, which triggers the service, (2) observing and monitoring to determine the location, structure and environment of the storm, and (3) prediction of the future location and structure.

In the early years, detection usually occurred during the relatively late stages of a hurricane's life. Even with the advent of radiotelegraphy, detection was very much a matter of chance coincidence of the event and the observer. The early days of aerial reconnaissance improved the detection phase of the service as the aircraft became an instrument to verify cyclonic development when other observations indicated suspect circulations. In recent years, the weather satellite has become the primary detection instrument. The polar orbiting and geostationary satellites keep a constant watch over the vast ocean areas for incipient tropical disturbances which may develop into hurricanes.

The observation and monitoring phase of the hurricane weather service stands in sharp contrast to the same phase of other weather services. The first step in a forecast and warning program is to determine the conditions that exist at the time the forecast is prepared and what has occurred during the past few hours or days. Over the continental United States, surface and upper air observational networks have been established over the years. The rather dense surface network provides observations hourly while the less dense upper air network (one observation point for about every 40,000 square miles) provides measurements of pressure, wind, temperature, and moisture every 12 hours as a function of altitude. These observations are supplemented by data from an extensive aging radar network, reports from commercial aircraft, and data from satellites. These data are analyzed by computers and forecasters and input to numerical models to determine present locations, strengths, and changes with time of existing weather phenomena and to predict future changes. The meteorologist uses this package of information as guidance for preparing and issuing forecasts and warnings.

The situation is quite different over the large ocean areas in the tropical and subtropical regions where hurricanes form. Surface observations are routinely received only from a sparse island network and a few strategically placed buoys. These are supplemented by sporadic, but extremely important, ship reports. Upper air stations are almost nonexistent in these areas. More than four million square miles of tropical and subtropical waters from Africa westward to the Caribbean Sea and the U. S. southeast coast have no upper air stations. A network of upper air stations does exist on the island chain and continental coasts surrounding the Caribbean Sea and Gulf of Mexico. Again, however, there are literally hundreds of thousands of square miles where no upper air stations exist.

Other means of obtaining meteorological information over these sparse data areas are used. Through the cooperative efforts of National Oceanic and Atmospheric Administration (NOAA), DOD, National Aeronautics and Space Administration (NASA), Department of Transportation (DOT), the University of Wisconsin, private industry, and others, three primary systems for data collection have been developed for monitoring the tropical atmosphere and for tracking hurricanes. These systems are weather satellites (Goddard Space Flight Center, 1980), weather reconnaissance aircraft, and coastal weather radar systems which are used to supplement the sparse data available over these areas. Each of these systems has its strengths and weaknesses. Fortunately, their capabilities are generally complementary, and each is needed for its unique contribution to the total capability. For instance, satellites provide nearly continuous large scale coverage anywhere over the tropical waters, but to date cannot provide detailed, high-accuracy information on the strength, location, and wind field distribution in a tropical storm or hurricane. Reconnaissance aircraft provide detailed information on the internal storm structure, but cannot provide information on temporal and spatial scales in the meteorological environment surrounding the hurricane. Land-based coastal radar systems provide continuous detailed information on the strength and windfields, and larger scale environmental flow patterns. Consequently, satellite data are used to monitor continuously the tropics and potential areas of storm development. When a storm develops, the satellite is used to track the storm's general movement and to provide estimates of intensity. Then specially instrumented weather reconnaissance aircraft are used to obtain more detailed information on the storm's strength, movement, and structure to supplement the satellite coverage.

As a hurricane nears landfall (within 200 miles), the reconnaissance aircraft and satellite data coverage is supplemented by a coastal radar network. Current radar systems provide detailed tracking and precipitation field information but only qualitative estimates of storm strength and wind field distributions can be determined. By the time the center of the hurricane is within range of the coastal radar network, warnings usually have already been issued. The radar is then a tool for refining or extending warnings. Warnings could be extended if the storm moves nearly parallel to the coast or if it changes direction of motion during the last few hours before and during landfall.

The two most critical elements to forecast are the hurricane's future intensity (including wind and precipitation field distributions) and its movement. The first step in the forecast process is to determine the existing meteorological conditions and how these conditions are changing with time. Some known critical factors for the assessment of future changes in intensity are the:

- Temperature of the ocean surface in the vicinity of the storm. Warm water is favorable for strengthening and cold water favorable for weakening.
- Shear of the horizontal wind with height. Wind speeds and directions similar at low, middle and upper levels in the troposphere, i.e., low shear, are favorable for strengthening the storm since it favors concentration of heat energy and lowering of surface pressures, whereas, large differences in wind speed and/or direction at various levels weaken the storm since it ventilates the system rapidly and inhibits concentration of heat.
- Presence of deep moist layers in the lower and middle troposphere.

The dominant influence on the movement of a hurricane is the surrounding large-scale flow in which the hurricane is embedded. This flow is often referred to as the steering current or advection and is the primary consideration in forecasting storm movement. Another factor contributing to the storm movement is the interaction of the storm center with the overall flow, including asymmetric heating (Sheets, 1981).

Future Developments in Hurricane Forecasting

Two major efforts are underway to improve forecasts of the hurricane intensity and movement. They are, (1) to enhance the quality and quantity of data availability in and around the hurricane as well as over the vast oceanic areas of interest, and (2) to improve existing numerical models and to develop new models that could take advantage of the improved data.

Efforts relating to the enhancement of quality and quantity of data include:

- Recent developments in weather satellite technology to alleviate some of the observational problems by describing the environment in which the storm is embedded, (Grody and Shen, 1982, and Wilheit, et. al, 1977). Of particular interest, is the experimental VISSR Atmospheric Sounder (VAS) satellite program developed and being evaluated by several groups within NASA, NOAA, the University of Wisconsin, and others (Menzel, et. al., 1981 and Smith et. al., 1981).
- A NOAA and DOD cooperative effort to develop an Improved Weather Reconnaissance (IWR) system to provide accurate, high-density information on the storm structure's and to develop a reliable means to communicate

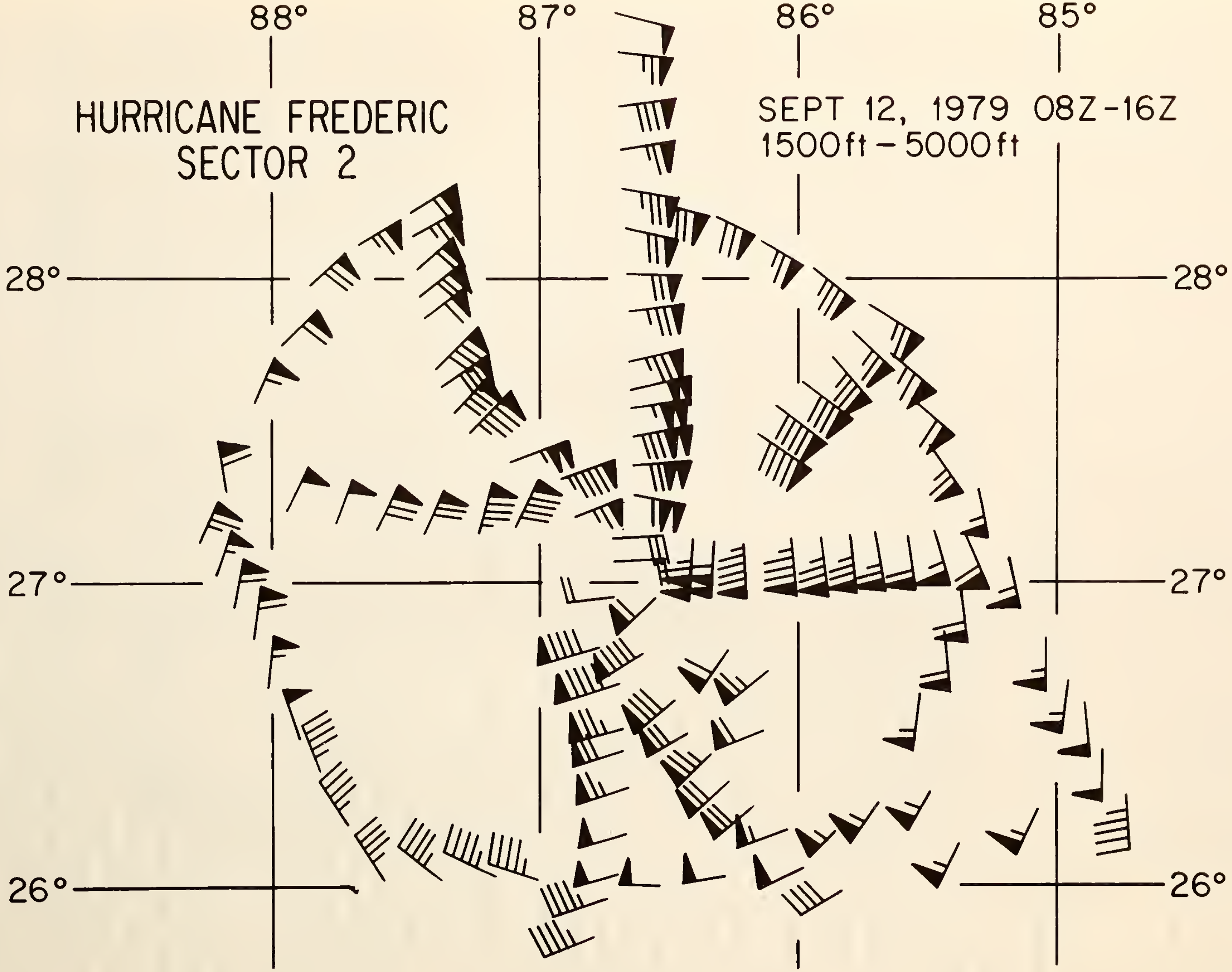


Figure 1.3. High Density, High Accuracy Data Obtained by NOAA Research Aircraft

these data to the forecasters. The first operational system is scheduled for completion by the 1985 hurricane season.

- A study by Neumann (1982) which indicates that significant improvements in short term (12- to 24-hour) forecasts can be realized with improved initial storm position and motion definitions. Techniques have been developed which use the high density, high accuracy data shown in Figure 1.3 to obtain initial motion of the storm. Unfortunately, these types of data are only available from two NOAA research aircraft (Sheets, 1982). However, the Air Force C-130 reconnaissance fleet will be upgraded over the next few years under the Improved Weather Reconnaissance Program to provide these kinds of data. These data, if routinely available in real time, would not only improve hurricane movement forecasts, but also provide indications of short-term fluctuations of intensity. They will contribute to more accurate quantitative warnings.

- A Doppler weather radar system is being developed through cooperative efforts of the Department of Commerce (DOC), DOD and the Federal Aviation Administration (FAA). Under the NEXRAD Program, this advanced system should provide better indications of severe thunderstorm and tornado occurrences that are usually associated with hurricanes moving over land. It should also give indications of wind field strengths over and near land. These new radar systems will replace the old WSR-57 radars now in use.

The second major effort to improve forecasts is related to numerical models (Neumann and Pelissier, 1981). Existing analysis techniques and forecast models will need modification and new models must be developed to take advantage of these data improvements. Statistical and dynamical models are presently being modified at the National Hurricane Center (NHC), National Hurricane Research Laboratory (NHRL) and the National Meteorological Center (NMC). However, to use these new data, a next generation dynamic prediction model must be developed through the cooperative efforts of NHRL, NMC and NHC. Similar improvements in numerical forecasting models are being achieved and pursued within DOD by the Naval Environmental Prediction Research Facility (NEPRF) for very specific military requirements.

Organization, Coordination and Area Coverage of Aerial Reconnaissance

Throughout the program, the Department of Defense has had the primary responsibility for weather reconnaissance while NOAA aircraft (designed primarily for research projects) have played a supplementary role. Today, operational weather reconnaissance is provided by U. S. Air Force. The 54th Weather Reconnaissance Squadron of the Military Airlift Command (MAC) provides reconnaissance services in the Western Pacific for the Joint Typhoon Warning Center (JTWC) in Guam. The 53rd Weather Reconnaissance Squadron (MAC) and the 920th Weather Reconnaissance Group (U. S. Air Force Reserve) provide reconnaissance data for the National Hurricane Center (Miami), Eastern Pacific Hurricane Center (San Francisco), and the Central Pacific Hurricane Center (Honolulu). The latter two Air Force units, both stationed at Keesler AFB, Mississippi, also provide reconnaissance of winter storms. NOAA's two research aircraft fly special missions to provide high density/high accuracy data for storms near landfall.

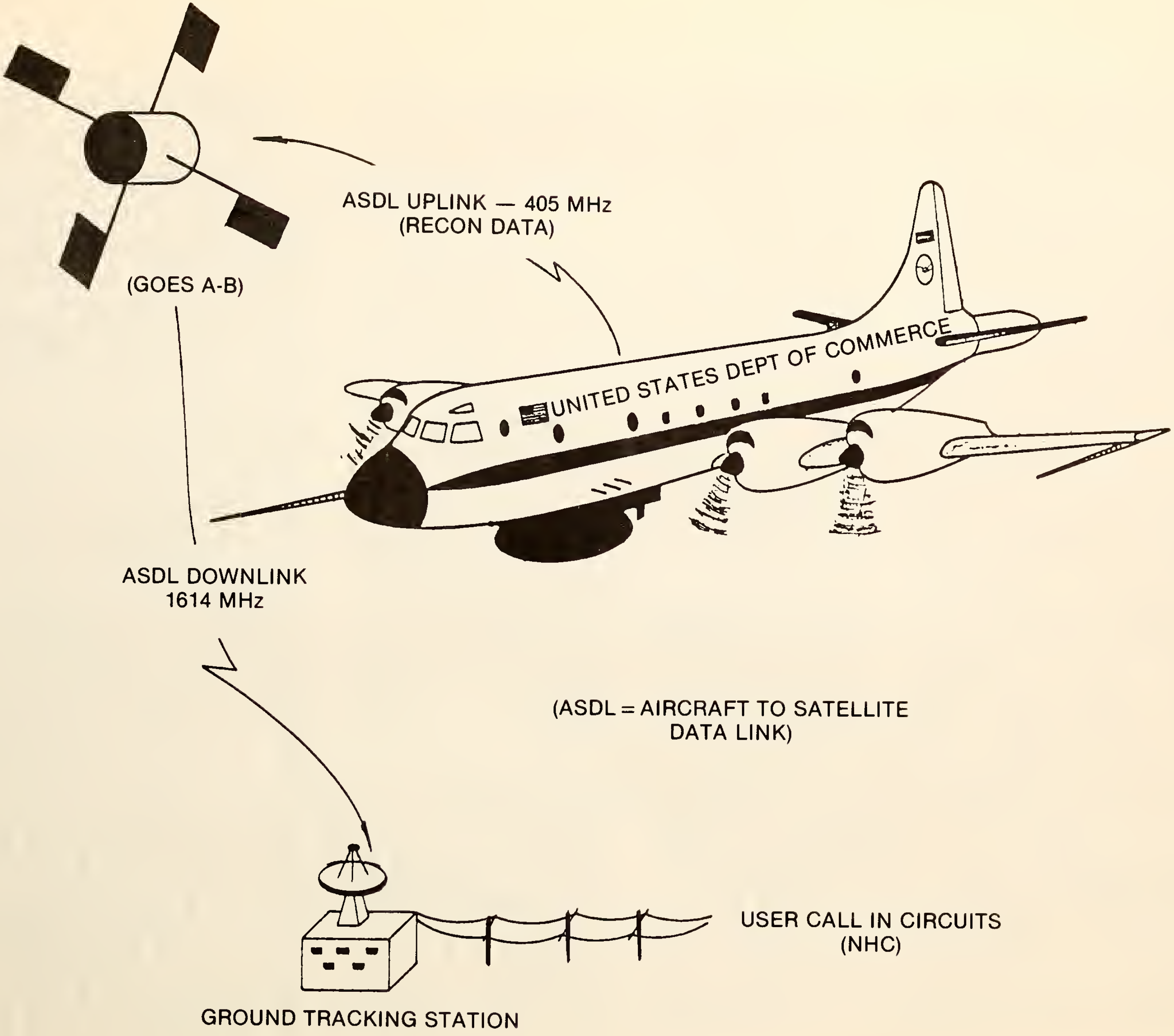


Figure 1.4. Schematic of Data Link, NOAA P-3 Aircraft to Satellite to National Hurricane Center

An Air Force unit, referred to as "Chief Aerial Reconnaissance Coordination, All Hurricanes" (CARCAH), is colocated with the the National Hurricane Center. CARCAH coordinates all requests for reconnaissance aircraft flights for the Central and Eastern North Pacific and for the Atlantic Ocean areas. This covers the northern tropics (north of $8^{\circ}N$) from about 1,700 miles off the Florida coast to about 1,700 miles west of Honolulu (the International Dateline). The area of most frequent storms and of greatest need for aerial reconnaissance is the Western Atlantic, Caribbean, and Gulf of Mexico. Aerial reconnaissance is normally carried out until the storm is within approximately 50 miles of coastal areas. For storms that are about 1,000 miles from Keesler AFB, MS, the aircraft will fly to an intermediate location and refuel before performing the storm reconnaissance.

The National Weather Service provides CARCAH with a list of required data for the selected storm situation for the next day and CARCAH arranges for the Air Force reconnaissance mission. If special high density/high accuracy data are required, (Sheets, 1978), CARCAH arranges for the NOAA research aircraft to collect the data.

During reconnaissance missions, aircraft collect data on the location and intensity of the storm along with wind field distributions near the storm's core. Data from Air Force aircraft are relayed by radio-phone patch from the aircraft to CARCAH. The much larger quantities of data provided by the research aircraft are transmitted via satellite to the National Hurricane Center. Figure 1.4 depicts the aircraft-to-satellite data link. Figure 1.5 shows a sample of the data transmitted by NOAA aircraft just before Hurricane FREDERIC (1979) moved inland over the Mississippi, Alabama and Florida panhandle coasts. Wind speeds of over 100 miles per hour covered a region from Biloxi, Mississippi, to near Pensacola, Florida. These critical data helped forecasters to provide excellent warnings for this storm which resulted in a small loss of life (5) despite the extreme property damage ($2.3 billion) caused as it moved inland.

The Future Role of Aerial Hurricane Reconnaissance

In the past, the broad role of hurricane reconnaissance had the effect of subjecting the program to a long series of compromises: aircraft endurance versus early detection versus the profiling capability; flight profiles versus expenditures for fuel and engine reliability; small samples of data over a vast area versus more data over a more restricted area.

Satellite sensors and Doppler weather radar development will allow aerial reconnaissance aircraft to concentrate on the vital task of providing a detailed description of the hurricane and its immediate environment over a 500-mile square which moves with and contains the hurricane. For storms that are within 150 miles of U. S. coastal areas, Doppler radar will provide detailed tracking information, estimates of storm strength, and detailed wind and precipitation fields. Satellites will satisfy detection and broad environ- mental measurement requirements. For the foreseeable future, aerial reconnais- sance of hurricanes is the best and only means of obtaining the needed detailed knowledge of the dynamic structure of hurricanes and their interaction with the broad environment.

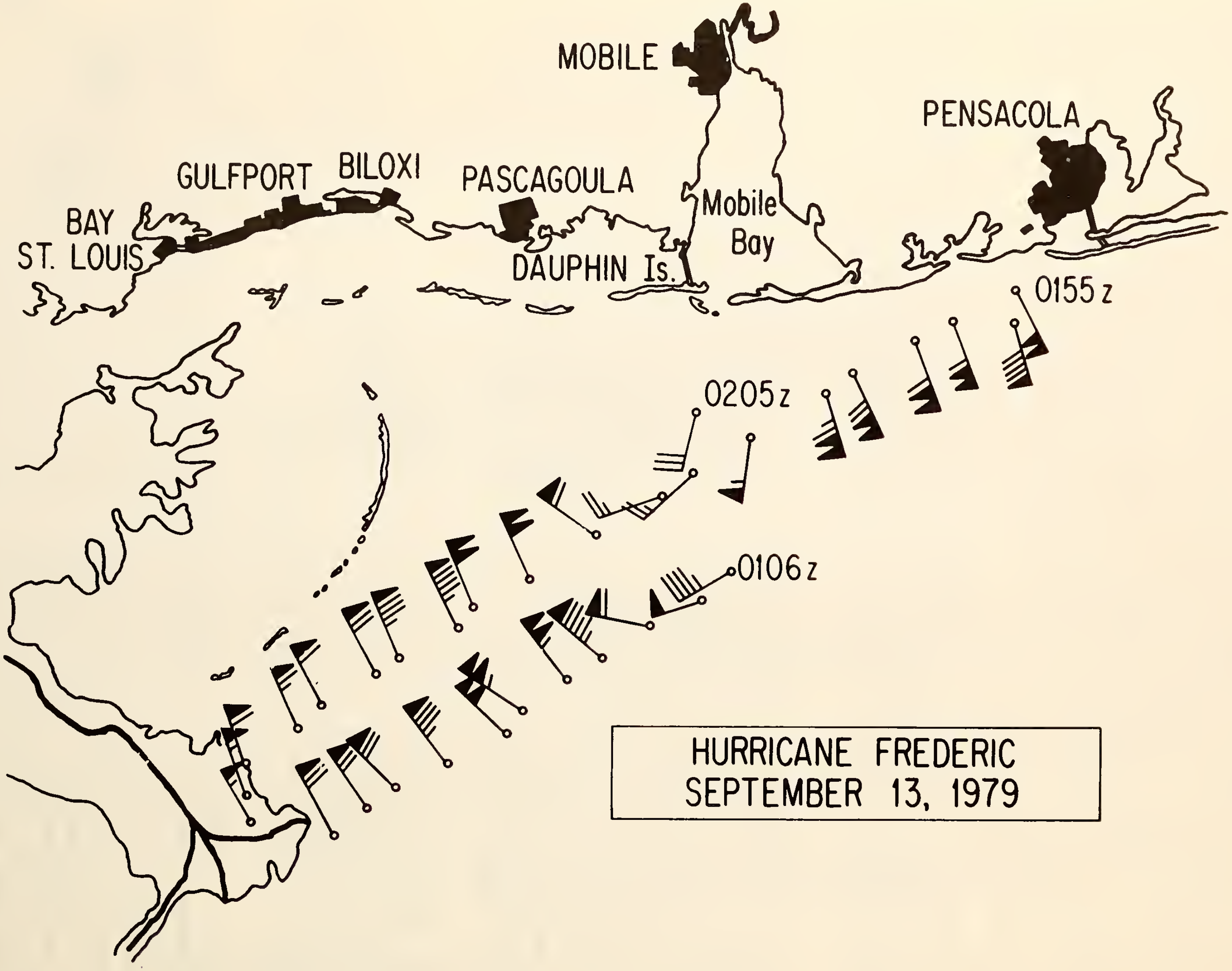


Figure 1.5. Sample of Data Transmitted by NOAA Research Aircraft

REFERENCES

Goddard Space Flight Center, 1980; "Execution Phase Project Plan for Operational Satellite Improvement Program Plan: VISSR Atmospheric Sounder (VAS) Demonstration." NASA Project Plan, Goddard Space Flight Center, Greenbelt, MD.

Grody, Norman C. and William C. Shen, 1982; "Observations of Hurricane David (1979) Using the Microwave Sounding Unit," NOAA Tech. Report NESS 88 April 1982, 52 pp.

Hebert, Paul J. and Glenn Taylor, 1983; "The Deadliest, Costliest, and Most Intense United States Hurricanes of This Century," to be published, NOAA Tech. Memo. NWS, NHC.

Menzel, W. Paul, et.al., 1981, "Visible Infrared Spin-Scan Radiometer Atmospheric Sounder Radiometric Calibration: An Inflight Evaluation from Intercomparisons with HIRS and Radiosonde Measurements," Applied Optics, Vol. 20, pp 3641-3644, October 15, 1981.

Neumann, Charles J., 1975; "A Statistical Study of Tropical Cyclone Positioning Errors with Economic Applications," NOAA Tech. Memo. NWS SR-82, March 1975, 21 pp.

Neumann, Charles J. and J. M. Pelissier, 1981; "Models for the Prediction of Tropical Cyclone Motion Over the North Atlantic: An Operational Evaluation," MWR, Vol. 109, No. 3., March 1981, pp 522-533.

Neumann, Charles J., 1982; "What Should be Done to Improve the Forecast?" Section 4, Review of Federal Research and Data Collection for Improving Tropical Cyclone Forecasts; Fed. Coord. for Met. Ser. and Sup. Res., U. S. Department of Commerce, NOAA, Rockville, MD 20852.

Sen, S. N., 1979; "Operational Techniques for Forecasting Tropical Cyclone Intensity and Movement" Chap. 1, World Weather Watch, WMO Tropical Cyclone Project - Sub-Project No. 6, WMO No. 528, Secretariat of the World Meteorological Organization, Geneva, Switzerland.

Sheets, Robert C., 1978; "Hurricane Anita - A New Era in Airbourne Research," Mariners Weather Log, Vol. 22, No. 1, pp 1-8, January 1978.

Sheets, Robert C., 1981; "Tropical Cyclone Modification: The Project STORMFURY Hypothesis," NOAA Tech. Rep. ERL 414 AOML 30, August 1981, 52 pp.

Sheets, Robert C., 1982; "On the Structure of Hurricanes as Revealed by Research Aircraft Data," Topics in Atmospheric and Oceanographic Sciences, Intense Atmospheric Vortices, Ed. by Bengtsson and Lighthill, pp 36-49, Springer-Verlag, Berlin Heidelberg, 1982.

Smith, W. L. et. al., 1981; "First Sounding Results from VAS-D," Bulletin of AMS, Vol. 62, No. 2, Feb. 1981, pp 232-236.

Wilheit, T. T. et. al., 1977; "A Satellite Technique for Quantitatively Mapping Rainfall Rates Over the Ocean," J. Appld. Met., Vol. 16, pp 551-560.

SECTION 2

FEDERAL COORDINATION AND PLANNING

In 1963, activities in meteorology gave rise to concern in Congress and the Executive Office of the President as to whether Federal meteorological activities were being coordinated adequately. This concern was given expression by the Congress in Section 304 of Public Law 87-843, the Appropriations Act for State, Justice, Commerce, and Related Agencies.

The Bureau of the Budget (now OMB) issued a report entitled "Survey of Federal Meteorological Activities" (1963). It described each agency's program in some detail, particularly its operational services, and spelled out the relations between the programs of the various agencies. The report revealed close cooperation but little evidence of systematic coordination. As a result of this study and the concern of Congress, the Director of the Bureau of the Budget issued Circular A-62. The Circular provided the ground rules to be followed in the coordination process. It established a general philosophy for assignment and assessment of agency roles in the field of meteorology and set certain goals to be achieved by the coordination process. The Circular left to the Department of Commerce (DOC), in concert with the other Federal agencies, the task of establishing the coordinating mechanism. In the field of meteorology, the Circular reaffirmed the concept of having a central agency, the Department of Commerce, responsible for providing common facilities and services and clarified the responsibilities of other agencies for providing specialized meteorological services.

Commerce's implementation of these responsibilities resulted in creation of the Office of the Federal Coordinator for Meteorological Services and Supporting Research within the National Oceanic and Atmospheric Administration (NOAA). The principal work in the coordination of meteorological activities and in the preparation and maintenance of Federal Plans is carried on by the staff of the Federal Coordinator with the advice and assistance of an Interdepartmental Committee for Meteorological Services and Supporting Research.

MISSION AND STAFFING OF THE OFFICE OF THE FEDERAL COORDINATOR FOR METEOROLOGY (OFCM)

The mission of the OFCM is to promote coordination and cooperation among the Federal weather agencies so that the best weather information is available to users at the least cost to the Government. To discharge its mission, the OFCM objectives are overlaid on the objectives of those agencies who provide the services and perform the research. The objectives are to:

- Review the set of Federal weather programs and total Federal requirements for weather services. This review may suggest additions or revisions to current or proposed programs; or, identify opportunities for improved efficiencies, reliability, or savings through coordinated actions or integrated programs.

- Document agency programs and activities in a series of National plans and reports that enable agencies to revise or adjust their individual ongoing programs, and provide a means for communicating new ideas and approaches to the solution of problems.
- Perform analyses, summaries or evaluations of agency meteorological programs and plans that provide a factual basis for the Executive and Legislative branches to make appropriate decisions related to the allocation of funds.
- Provide a structure and program to promote continuity in the development and coordination of plans and procedures for interagency meteorological service operations and supporting research activities.

In 1979, a General Accounting Office (GAO) report, ("The Federal Weather Program Must Have Stronger Central Direction," LCS-80-10) recommended stronger centralized planning and direction for Federal weather activities. Pursuant to GAO's recommendation, the DOC increased the staff and provided other resources to the Office of the Federal Coordinator. Based on current staffing, there are 96 professional staff-months available within the OFCM. Approximately one-half of these resources is required for the direct support of the Committee structure and preparation of recurring plans (National Operations Plans and the annual Federal Plan). The remaining staff time is available for responding to special inquiries, investigations and studies. The Department of Transportation (DOT) and Department of Defense (DOD) each contribute approximately $250K per year to the operation of the OFCM. The DOD also provides two staff officers (one Air Force Colonel and one Navy Captain) and the FAA one GS-15.

SPECIFIC COORDINATION OF MULTIAGENCY PROGRAMS

The Federal Committee for Meteorological Services and Supporting Research was established in 1964 with agency representation at the Assistant Secretary level to provide policy guidance to the Federal Coordinator, to review and validate the annual Federal Plan for Meteorological Services and Supporting Research and to resolve agency differences that arise during the coordination of meteorological activities and the preparation of Federal plans in general.

Twelve Governmental agencies engaged in meteorological activities, or that have a need for meteorological services, are represented on the committee. These include the Departments of Commerce, Agriculture, Defense, Energy, Interior, State, and Transportation as well as the Environmental Protection Agency, Federal Emergency Management Agency, National Aeronautics and Space Administration, National Science Foundation and the U. S. Nuclear Regulatory Commission.

The Office of Management and Budget (OMB) and the Federal Committee provide guidance at the policy level to the Federal Coordinator. Guidance from the agencies, at the program management level, is provided by the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR). Under ICMSSR there are five standing committees for Basic Services, Systems Development, Aviation Services, Operational Environmental Satellites, and Space Environmental Forecasting. Under the standing committees are working groups to coordinate specific agency activities. All of the committee and working group chairmen are designated by the agencies involved. One working group is developing comprehensive backup support plans for the operational processing centers: National Meteorological Center (NMC); Fleet Numerical Oceanography Center (FNOC); and the Air Force Global Weather Central (AFGWC). To achieve backup, the group has stressed the need for standardization. Another group is establishing standards that will allow automated weather information systems of NOAA, Navy, Air Force and FAA to exchange meteorological data. During FY 1983-84, the major efforts of the interagency committees and the OFCM will be concentrated in the areas and tasks described in the remainder of this section.

Next Generation Weather Radar (NEXRAD)

The Departments of Commerce (DOC), Defense (DOD), and Transportation (DOT) all require information concerning the location, intensity, and movement of hazardous weather activity to meet their mission responsibilities. These three Departments have stated a common need for a radar system with improved capabilities for detecting hazardous weather conditions. In 1979, the Federal Committee for Meteorologicial Services and Supporting Research endorsed the establishment of a Joint System Program Office (JSPO) as a focal point for the NEXRAD program. At the end of fiscal year 1982, the staff included 13 persons from DOC, three from DOD, and three from DOT. The NEXRAD JSPO is located in the National Weather Service, a component of DOC's National Oceanic and Atmospheric Administration.

NEXRAD will provide a Doppler radar core for a national network of weather radar systems. A study to be completed during 1983 will make a life cycle cost comparison between an all-Doppler network and a mixed network of Doppler and non-Doppler radar systems. A total of about 160 radars are required to meet the needs of the three Departments and the radar systems are being procured in accordance with the guidelines for major system acquisitions laid out in OMB Circular A-109. The first phase in this four-phase process called for the development of a system design. The three contractors selected for the System Definition Phase in February 1982 submitted their final, competitive designs in November 1982. Two of these contractors will be selected in early 1983 to develop and demonstrate their system designs during the Validation Phase.

The Validation Phase will be divided into two parts. The first part emphasizes the reduction of risk in major subsystems with primary emphasis on the data processing and software design. The second part of the Validation Phase will complete the development and testing including some interim operational testing of competing preproduction models. Following validation, the NEXRAD JSPO plans to complete operational test and evaluation of the selected contractor's system during the Limited Production Phase.

Planned Activities for FY 1983:

o Begin Validation Phase Part 1	April 1983
o Begin Validation Phase Part 2	March 1984
o Validate meteorological algorithms for initial operating configuration:	
First Report	April 1983
Final Report	February 1984
o Begin site surveys	August 1983

Automated Surface Observations

The Departments of Commerce, Defense, and Transportation maintain over 1,000 weather observing sites requiring an estimated 1,000 staff-years annually. Most surface observations are taken manually and consume a significant amount of staff time that could be more effectively directed toward the more demanding services of the agencies. In addition, sensor maintainability and reliability degradations are presenting significant problems. A typical observing station now costs about $20,000 per year to maintain, and it is projected to increase about 10 percent per year (in real terms) because of the increasing age and obsolescence of many of the existing sensors and the increasing difficulty of obtaining replacement parts. Consequently, selective replacement of obsolete sensors is now taking place just to retain the current capability.

Programs to develop automated observing equipment have been underway in the three Departments for some time. These programs have demonstrated the feasibility of automation for many weather parameters. The Office of the Federal Coordinator for Meteorology (OFCM) conducted a crosscut study in 1979 and concluded that the Departments of Commerce, Defense, and Transportation have common requirements, and recommended that programs be merged, to the extent possible, into a joint development and procurement effort. The OFCM also concluded that surface automation was a cost effective solution to the workload and increasing maintenance problems.

In response to guidance from the Office of Management and Budget (OMB), the three Departments formed the Joint Automated Weather Observation Program (JAWOP). A Program Council was established to provide policy guidance and oversight. The Council is chaired by the Federal Coordinator, as an advisory member, and is comprised of one designated representative from each of the three participating agencies. JAWOP will be limited in scope to addressing the requirements of the Departments of Commerce, Defense, and Transportation, each of which has significant weather observing activities that directly support aviation operations. Coordination of JAWOP with other Departments will be accomplished by the OFCM.

Automated systems under JAWOP will employ a modular design to permit deployment of basic partial automated systems as soon as possible to meet some of the requirements before full automation is achievable. Active development and testing of systems and key sensors are being carried out by the three agencies to meet unique agency requirements.

The Federal Aviation Administration (FAA) has awarded contracts to demonstrate operationally at 21 airports three commercially available automated surface weather observing and reporting systems. These limited systems will give the pilot, via radio, the wind direction and speed, altimeter setting, visibility, ceiling, and temperature. These systems, called the Automated Weather Observation System (AWOS), are part of the Joint Automated Weather Observing Program (JAWOP).

The National Weather Service (NWS) has developed, and is now field testing, a Laser Weather Identifier and associated algorithms for the reporting of present weather and obstruction to vision. This development is crucial to full automation. NWS has initiated the procurement of demonstration systems that satisfy unique NWS requirements -- referred to as the Automated Surface

Observing System (ASOS). Plans call for deployment of six systems in an operational test of observing and forecasting impacts. Additional systems will be placed in climatic test beds for further development of key sensors and algorithms. System capabilities include the detection of clouds to 10,000 feet, present weather, observer augmentation, archiving, special observations, daily summary, and AFOS communications.

The Air Force activity in automated sensor development is principally the responsibility of the Air Force Geophysics Laboratory (AFGL). Sensor development, test and evaluation are carried out by AFGL at Otis AFB, MA. Efforts are concentrated on the specification and prediction of airfield parameters for which an automated solution does not presently exist. For example, the automation of type and intensity of present weather. A further effort will be to determine the availability and utility of instruments and techniques for providing weather such as visibility and cloud height for AF tactical operations. Ongoing procurement and replacement of sensors include solid state temperature-humidity-pressure devices and a cloud height indicator. The procurement of a wind sensor replacement is planned in the near future.

Planned Activities for FY 1983 and FY 1984:

- FAA will conduct operational tests and field demonstrations of three commercially available systems at 21 airports.
- FAA will continue the evaluation of visibility sensors at the Transportation Systems Center in Cambridge, MA.
- FAA will coordinate and finalize specifications for production systems and will release an RFP for production systems.
- NWS will complete evaluation of the Laser Weather Identifier and associated present weather algorithms.
- NWS will procure ASOS demonstration units and will begin operational testing of these units.
- USAF will continue selective replacement of aging sensors.

Automated Aircraft Reporting System

Development of the automated aircraft reporting system moved into an international phase during FY 1982. This was largely due to the demonstrated success of the experimental ASDAR (Aircraft to Satellite Data Relay) and the VHF air-to-ground systems and the stated requirement for data from these systems by the national meteorological services of many countries.

An international Consortium on ASDAR Development (CAD) was created by interested countries to contract for fabrication of preproduction ASDAR units, including flight certification. The purpose is to make available a standard commercially available and logistically supportable ASDAR product on a worldwide basis. The consortium consists of several countries which have contributed financially to the development. Saudi Arabia has contributed about 60% of the funds whereas the U. S. has contributed about 10% plus technical expertise. Several other countries have contributed the remaining 30% of the funding. A contractor was selected to build the preproduction units to specifications developed largely through the effort of the National Weather Service (NWS) and coordinated under the auspices of the Federal Coordinator.

Meanwhile, the experimental ASDAR units continue to operate on several international airlines' Boeing 747 aircraft free of charge. Maintenance is accomplished on a unit replacement basis in cooperation with the airlines by the Federal Aviation Administration. The experimental VHF air-to-ground systems are flown and maintained within the U.S. by an U.S. airline under a NWS contract. Continuing experience, tests, and evaluation of these systems were used to prepare U.S. proposals for ASDAR Maintenance, Data Quality Control, and the Operational Use of ASDAR Data. These proposals were submitted to the World Meteorological Organization's committee on ASDAR participants and to the CAD.

The experimental system called ASDAR (developed for the First Global Atmospheric Research Program Experiment (FGGE) held during 1978-1979) demonstrated the operational feasibility of automated aircraft reporting of meteorological data. The objectives of FGGE were to extend the range, scope, and accuracy of weather forecasts, and to understand the physical basis of climate and climate fluctuations. The objective of the ASDAR part of the experiment was to acquire good, reliable, and timely upper air data in sparse data areas to support the program.

In addition to ASDAR, which reports data through geosynchronous meteorological satellites, similar equipment was placed on 11 wide-body jets equipped with Inertial Navigation Systems (INS). These jets were flying principally U.S. mainland routes. The purpose of this equipment was to test the feasibility of acquiring profile weather data during ascent and descent of aircraft at airports and the feasibility of using the existing VHF air-to-ground and ground-to-ground communications to relay the high volume of data to the major weather processing centers within the U. S.

In response to the major meteorological processing centers, the Working Group on Operational Processing Centers requested the ICMSSR to keep the experimental flight hardware from being phased out, to develop a new generation of equipment suitable for commercial production, and to expand the operational use of the system. The NASA, DOT, DOD, and DOC members of ICMSSR arranged for the resources to keep the current flight hardware system operating, and to study and plan for the expansion of the system. The Working Group on Automated Aircraft Reporting (WG/AAR) is the major forum for exchanging ideas, for identifying problems and discussing alternative solutions, and for developing a program development plan that will meet national and international requirements.

Planned Activities for FY 1983:

- o Fabrication and certification of preproduction ASDAR units by contractor.
- o Continue experimental ASDAR and VHF air-to-ground systems operations.
- o Refine standards, operational procedures, logistics, and use of the data.

Improved Weather Reconnaissance System

Currently, the United States Air Force (USAF) has 20 aircraft whose mission is tactical military reconnaissance in support of DOD requirements and reconnaissance of tropical cyclones and winter storms in support of joint DOD and DOC requirements. The National Oceanic and Atmospheric Administration (NOAA) reimburses the USAF for operational missions that support the National Hurricane Center (NHC) and the National Meteorological Center (NMC). The National Weather Service (NWS) has stated a need for high density, high-precision reconnaissance data, especially during the 48-hour period prior to landfall. This cannot be met today because only the two NOAA research aircraft and one USAF aircraft have the instrumentation to provide the necessary information.

The Federal Coordinator for Meteorological Services and Supporting Research and the National Academy of Sciences have studied the forecasting problem and the need for aircraft data. They concluded that an improved reconnaissance capability is essential for current operational forecasting and to provide the data required for the 1980's and beyond for new meteorological models of the NMC.

In October 1975, OMB asked the DOC and DOD to coordinate the modernization of reconnaissance aircraft and to arrange for joint funding. However, the initial and subsequent programs to meet these needs have not been included in the funding levels of either department. Consequently, the current operational aircraft horizontal observation system is essentially the same as it was 15 years ago. It is manual and lacks the accuracy, reliability, and sampling frequency needed for the current operational hurricane prediction models. A vertical observation system was developed by NOAA for the Global Weather Experiment in 1979. After the conclusion of the program, seven of the palletized Omega Dropwindsonde Systems (ODWS) were modified to meet NOAA and DOD needs and transferred to the USAF for use in the 14 aircraft based at Keesler AFB, MS. The ODWS pallets can be easily moved from one aircraft to another to allow flexibility in aircraft scheduling.

An Atmospheric Distributed Data System (ADDS) was designed and installed on one USAF aircraft to meet the requirement for accurate high density horizontal weather observations. Feasibility of the ADDS design was successfully demonstrated. The demonstration model did not completely satisfy the requirements in maintainability and reliability, but the engineering and software specifications have been changed to eliminate that deficiency.

DOD and NOAA agree that a combination of the existing dropwindsonde system with the redesigned ADDS and a communications system through the Air Force Satellite Communications System (AFSATCOM) would substantially fulfill the requirements. They have initiated a joint funded effort to equip and test a complete preproduction model on one USAF WC-130 aircraft in FY 1983/84. Pending a successful evaluation of the equipment, the remaining USAF weather reconnaissance fleet would be equipped in the next few years.

Planned Activities for FY 1983:

- Revise specifications for the preproduction IWR system.
- Award the contract and begin construction of IWR.

Planned Activities for FY 1984:

- Complete construction and install the preproduction IWR system on WC-130 aircraft.
- Begin flight tests of IWR system.

Planned Activities for FY 1985:

- Complete IWR flight tests.
- Contract for upgrading the remaining WC-130 aircraft.

Meteorological Planning for Emergencies

As a result of the Three Mile Island nuclear power plant incident, contingency plans were formalized to provide meteorological services during radiological emergencies. During FY 1981, the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR), at the request of the Federal Emergency Management Agency (FEMA), established the Task Group on Meteorological Plans for Radiological Emergency Responses (TG-MPRER). The TG-MPRER prepared the "National Plan for Radiological Emergencies at Commercial Nuclear Power Plants." The plan, approved by the ICMSSR, has been published and FEMA has agreed to incorporate the plan as the meteorological part of the overall Federal plan for radiological emergencies.

During 1983, the Task Group will prepare contingency plans for other radiological emergencies.

Automated Weather Information Systems

The GAO, in its October 16, 1979, Report to the Congress, stated that overlapping Federal weather programs have concerned both the Congress and the OMB for more than a decade. One of the concerns raised in the report involves development of systems to automate the transmission and display of weather charts, forecasts, and other information. In response to this concern, the Federal Coordinator asked ICMSSR to examine the adequacy of interagency coordination and possibilities for savings through joint development and procurement actions involving these systems. As a result, the Working Group on Automated Weather Information Systems (WG/AWIS) was established under the ICMSSR Subcommittee on Systems Development to coordinate the planning, development, and implementation of new weather information systems.

The principal systems under study are the Automation of Field Operations and Services (AFOS) of the National Weather Service, the Naval Environmental Display Station (NEDS) of the Navy, the Automated Weather Distribution System (AWDS) of the Air Force, and the Flight Service Automation System (FSAS) of the Federal Aviation Administration. The NEDS has been operational at central locations for several years and is now extending its service to remote terminal operations. AFOS became the primary operating service system of the National Weather Service in the conterminous 48 States in August 1982. Initial actions have been taken to extend its service to the smaller field stations via remote terminal operations. Early production models for the FSAS are being fabricated, and the initial Request for Proposals for AWDS is imminent.

The Working Group on Automated Weather Information Systems (WG/AWIS) has published its reports in a two-part volume, "Automated Weather Information Systems (AWIS): Considerations for Intra- and Intersystem Operations and Interagency Considerations in Development and Coordination" (FCM-R5-1982). The WG/AWIS also published the initial standards document, prepared by its Task Group on Communications Interfaces and Data Exchange (TG/CIDE), "Standard Formats for Weather Exchange Among Automated Weather Information Systems" (FCM-S2-1982).

In light of the progress of the various AWISs and their impact on all aspects of weather service operations, the WG/AWIS along with TG/CIDE have been elevated to report directly to the ICMSSR.

Planned Activities for FY 1983:

- Augment the format standards document (FCM-S2-1982) and review with the objective of identifying the most desirable options where such exist.
- Prepare and submit for agency coordination a policy document on the employment of standards in AWIS operations.
- Develop an additional set of standards.
- Initiate an annual report on the status of AWISs.

Improving Forecast of Icing Conditions for Aviation

The National Transportation Safety Board (NTSB), in Safety Report NTSB-SR-81-1, recommended that the OFCM develop icing instrumentation to collect icing data on a real-time basis and to develop techniques to forecast icing conditions. The ICMSSR requested the Committee on Aviation Services (CAS) to consider the NTSB recommendations and to suggest a course of action. The CAS published a report FCM-R4 which concluded that further improvements in the forecasts of icing conditions are needed.

The CAS recommends that the OFCM seek contractual support to survey the current state-of-the-art and develop an R&D plan for the improvement of the forecasting of icing conditions. The plan will define a course of action leading to improved icing forecasts to be undertaken by the supporting agencies.

Long-Term Federal Plan

The OFCM has undertaken the development of a Long-Term Federal Plan for meteorological services and supporting research. An initial contract was awarded in September 1982 to design the plan and identify any supporting analyses required for its completion. This contract is to be completed by July 1983.

The first phase of the effort is to analyze existing plans for compatibility and information voids. The second phase will include the development of a conceptual structure and a prototype plan. The final phase will include an analysis of alternative approaches to resolving the planning issues and a recommended plan of action.

The central group involved in this planning process consists of the Assistant Federal Coordinators assigned to the OFCM and focal points from each agency which contributes to, or are end users of, the Federal weather services.

COORDINATION OF PUBLICATIONS AND PLANNING ACTIVITIES

Federal Coordination of Meteorological Publications

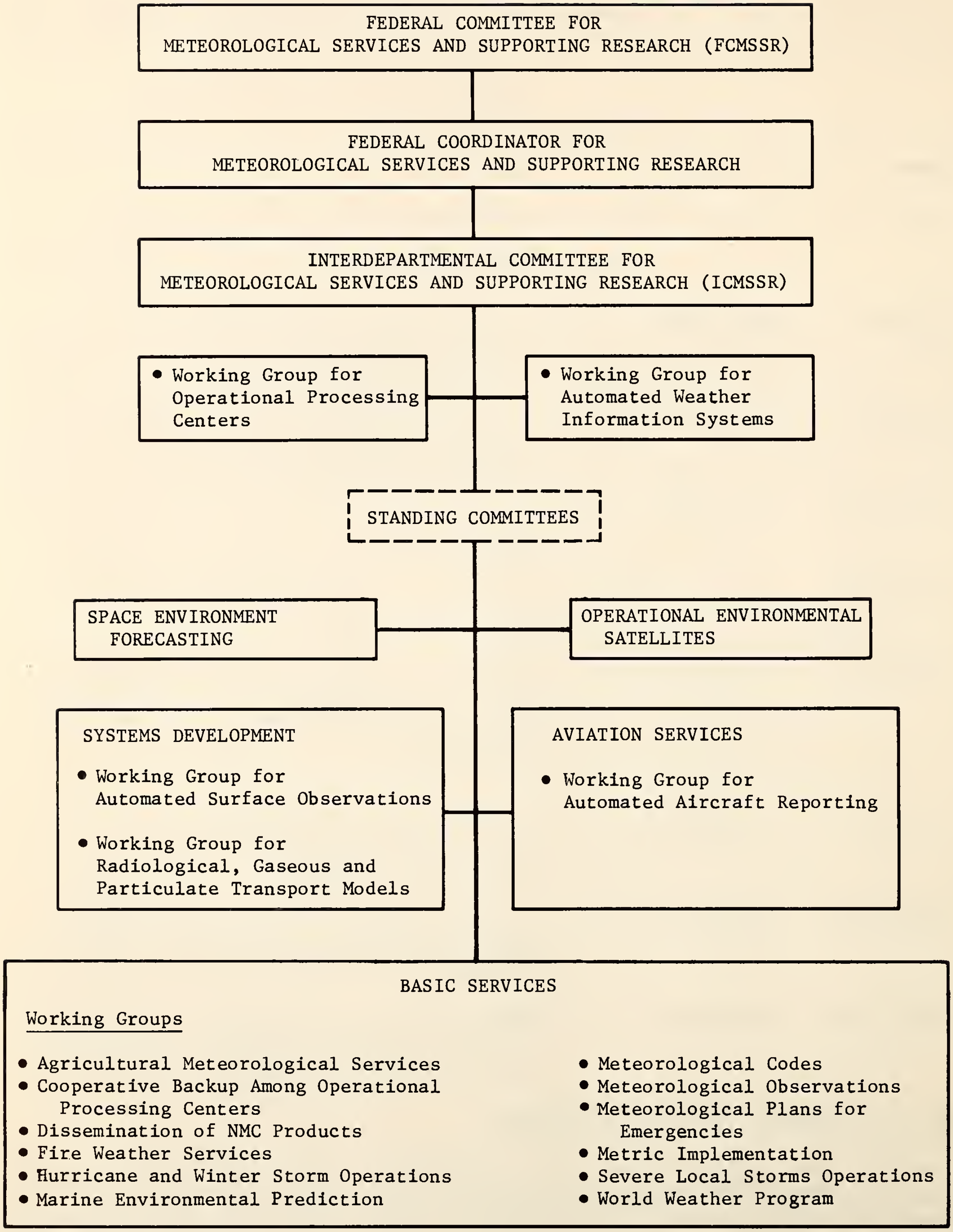
The preparation of Federal plans is a major responsiibility of the Federal Coordinator and requires extensive planning and coordination. Generally, Federal plans are prepared for each of the specialized meteorological services and for meteorological programs common to two or more agencies. In most cases, the preparation of Federal plans is facilitated by the existence of individual agency plans for the service or program involved. The Federal Coordinator compiles input from the involved agencies and proposes a unified plan for consideration. The Federal Coordinator for Meteorology publications series is as follows:

Number	Date	Title
FCM-P1-83	March 1983	Federal Plan for Meteorological Services and Supporting Research - Fiscal Year 1984
FCM-P2	(pending)	Long Range Federal Plan for Meteorological Services and Supporting Research
FCM-P3	(pending)	OFCM Activities Plan
FCM-P5	(pending)	Satellite Plans
FCM-P6	(pending)	Radar Plans
FCM-P7	(pending)	Surface Observing Plans
FCM-P8	(pending)	Aircraft Reporting Plans
FCM-P9	(pending)	Agriculture Weather Plan
FCM-P11-83	December 1982	National Severe Local Storms Operations Plan
FCM-P12-82	May 1982	National Hurricane Operations Plan (1983 revision due May 1983)
FCM-P13-81	September 1981 September 1982	National Winter Storms Operations Plan (page revision)

FCM-P14-81	January 1981	Federal Plans for Cooperative Backup Among Operational Processing Centers
FCM-P15-82	November 1982	National Plan for Radiological Emergencies at Commercial Nuclear Power Plants
FCM-P16	(pending)	Fire Weather Operations Plan
FCM-P17-82	February 1982	The National Plan for Stratospheric Ozone Monitoring and Early Detection of Change
FCM-R1-81	May 1981	A Report on the Plans for Coordination of Major Automated Weather Information Systems
FCM-R2-82	November 1982	Review of Federal Research and Data Collection Programs for Improving Tropical Cyclone Forecasting
FCM-R3-82	June 1982	An Overview of Applied Visibility Fundamentals
FCM-R4-82	February 1982	A Report on Improving Forecasts of Icing Conditions for Aviation
FCM-R5-82	September 1982	Automated Weather Information Systems (AWIS): Considerations for Intra- and Intersystem Operations and Interagency Considerations in Development and Coordination
FCM-S1-82	November 1981	Federal Standard Definitions for Meteorological Services and Supporting Research
FCM-S2-82	August 1982	Standard Formats for Weather Exchange Among Automated Weather Information Systems
FCM-S3-83	(pending)	Standard Practices for Estimating the Surface Wind from Sea-State Observations from Aircraft and Sea-State Catalog

Review of the Federal Committee Structure

Recently the Office of the Federal Coordinator made a thorough review of the Federal Committee structure and submitted the changes listed below to the Interdepartmental Committee for Meteorological Services and Supporting Research. (A schematic of the realignment is found in Figure 2.1 and on the back inside cover of this Plan.)


FEDERAL COMMITTEE FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (FCMSSR)
FEDERAL COORDINATOR FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH
INTERDEPARTMENTAL COMMITTEE FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (ICMSSR)
• Working Group for Operational Processing Centers
• Working Group for Automated Weather Information Systems
STANDING COMMITTEES
SPACE ENVIRONMENT FORECASTING
OPERATIONAL ENVIRONMENTAL SATELLITES
SYSTEMS DEVELOPMENT
• Working Group for Automated Surface Observations
• Working Group for Radiological, Gaseous and Particulate Transport Models
AVIATION SERVICES
• Working Group for Automated Aircraft Reporting
BASIC SERVICES
Working Groups
• Agricultural Meteorological Services
• Cooperative Backup Among Operational Processing Centers
• Dissemination of NMC Products
• Fire Weather Services
• Hurricane and Winter Storm Operations
• Marine Environmental Prediction
• Meteorological Codes
• Meteorological Observations
• Meteorological Plans for Emergencies
• Metric Implementation
• Severe Local Storms Operations
• World Weather Program

Effective February 23, 1983

Figure 2.1. Structure of Federal Coordinating Committees

1. Chairmanship. No change was recommended. It is important to involve the agencies at the highest levels of the committee infrastructure. Therefore, the chairmanship of standing committees and working groups should continue to come from the agencies. To insure continuity and to reduce workload on agencies, the OFCM should continue to designate the Executive Secretaries of the committees and working groups.

2. Standing Committees. The FCMSSR and the ICMSSR were unchanged. The five standing subcommittees were retained, but the prefix "sub" was dropped; i.e., Subcommittee for Aviation Services became Committee for Aviation Services (CAS); the Subcommittee on Basic Services became Committee for Basic Services (CBS); the Subcommittee for Operational Environmental Satellites became Committee for Operational Environmental Satellites (COES); the Subcommittee on Systems Development becomes Committee for Systems Development (CSD), and the Subcommittee for Space Environment Forecasting became Committee for Space Environment Forecasting (CSEF). This change connotes a sense of functional independence of the standing committees that has always existed. Other than referring to the ICMSSR for policy matters, the standing committees have always been responsible for their own functional areas. The new title also implies that the standing committees will be proactive rather than reactive.

3. Working Groups.

a. The Ad Hoc Group on Automated Aircraft Reporting was reassigned as a working group to the Committee for Aviation Services. This task will probably continue for an indefinite period and should be related to a functional committee.

b. The Task Group on Meteorological Plans for Radiological Emergency Responses was redesignated as a Working Group on Meteorological Plans for Emergencies and was reassigned to the Committee on Basic Services (CBS). This task covers all emergencies and is important enough to be given permanent status and assigned to a functional committee.

c. The Ad Hoc Group on Meteorological Planning for Emergencies was inactive and was disestablished. If there is a requirement for emergency planning or coordination, the Working Group on Meteorological Plans for Emergencies could assume that task.

d. The Working Groups for Hurricane Operations and for Winter Storms Operations were combined to conserve paper work and staffing. The members of both groups are identical. The title was changed to Working Group for Hurricane and Winter Storm Operations.

e. The three Working Groups: Surface Observations, Upper Air Observations, and Weather Radar Observations were combined because all three are responsible for updating the Federal Meteorological Handbooks (FMHs). Some personnel adjustments were required, but the task of updating the handbooks now rests with a single group instead of three. The new title is Working Group for Meteorological Observations.

f. The Working Group for Fire Weather Services was restored by the ICMSSR and assigned to the CBS.

g. The Working Group for Weather Radar Systems under the SC/SD was eliminated due to its inactivity.

The recommended changes to the Federal committee structure are small and nondisruptive. The total number of working groups is now 15 -- a reduction of four from the previous arrangement. The end result should be a more responsive and efficient infrastructure.

Procedural Issues

There were a number of issues identified in an earlier version of a long-range plan, some of which the agencies believe to be of sufficient importance to warrant the expenditure of resources. Other issues may be identified during ICMSSR or standing committee deliberations; however, the OFCM considers the following to be of the highest priority for FY 1983-84:

- Role of the private sector.
- Centralization vs. decentralization of weather services.
- Technology assessment/transfer.
- Acquisition and retention of high technology personnel.
- Coordination of field structure reorganization.

SECTION 3

RESOURCE INFORMATION AND ANALYSES

The following tables summarize fiscal information of the Federal Government. The funds shown are those used to provide meteorological services and supporting research which has as its immediate objective the improvement of these services. A description of the basic ongoing programs is presented in Appendix A. All fiscal data are current as of the end of January 1983. These data are subject to later changes; they do not have executive or legislative approval and do not constitute a commitment by the U. S. Government.

AGENCY OBLIGATIONS FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH

The fiscal information in Table 3.1 is presented by agency for meteorologial operations and supporting research and shows the FY 1983 planned funding level, the budget request for FY 1984 and the net differences. The agencies plan to spend approximately $1,301 million in FY 1983 and have requested $1,237 million for FY 1984. This represents a net decrease of $65 million or approximately 5.0 percent.

Department of Agriculture (USDA)

The USDA planned funding level for FY 1983 is $8.96 million for operations and supporting research. This funding is almost entirely for conducting research (approximately $8.3 million) that focuses on understanding the interactions of weather and climate with plants and animals. The USDA also assists the Department of Commerce in determining farmers' needs for weather information and in disseminating such information to them. The budget request for FY 1984 is $8.87 million which is slightly lower than FY 1983 due to some realignment of activities in the Statistical Reporting Service of the USDA.

Department of Commerce (DOC)

The National Oceanic and Atmospheric Administration (NOAA) budget reporting structure was significantly changed for FY 1983. This has resulted in a better reflection of the distribution of the actual program costs within NOAA. However, comparison of projected FY 1983 expenditures against estimated FY 1983 is difficult and somewhat meaningless and will be omitted from this discussion.

The total NOAA FY 1984 request is only 0.9 percent higher than the FY 1983 planned programs. When inflation and pay increases are taken into account, this represents a moderate reduction in operational and supporting research programs. Nonetheless, the highest priority activities are being supported. However, there are increases due to satellites, NEXRAD and severe storm weather research.

Significant changes in NOAA's operations and supporting research from FY 1983 to FY 1984 are given below where changes are broken down according to the "activities used in NOAA's budget." Under Operations, Table 3.1 shows a net increase of $11.3 million. In FY 1984, NOAA plans the conversion of eight Weather Service Forecast Offices (WSFOs) to Weather Service Offices (WSOs) status for a net $836 thousand decrease and reduction of 42 positions. NOAA also proposes to consolidate four of the National Weather Service (NWS) Regions into three, resulting in a net decrease of $1.2 million and 31 positions. These actions will impact the budget activities discussed below -- Public Warning and Forecasts, and Environmental Satellite, Data and Information Services, as well as the program supporting activities.

- For its Public Warning and Forecast Service, there will be a net reduction of $7.4 million. In addition to the reductions noted above, this includes $525 thousand by discontinuing the extension of the NOAA Weather Wire circuit without line charges to new subscribers; $350 thousand by consolidation of aviation area forecasts at 12 WSFOs, and also consolidation of this function at the National Centers; $2.226 million by elimination of the Agricultural and Fruit Frost Programs and reduction in the Fire Weather Services; $407 thousand for consolidation of the Pacific and Alaska Regional Headquarters; $580 thousand for elimination of regional hydrologist offices; $1.975 million for reductions in WSFO and WSO staffing and services where these do not impact primary new weather services; $2.5 million associated with communications savings due to the full implementation of AFOS; $1.0 million for savings in general communications; and $1.5 million for NWS equipment and model research. These reductions are intended to eliminate unnecessary overhead and marginal services, and to discontinue specialized weather services which would more appropriately be provided by the private sector in order to focus resources on NWS' primary mission. An increase of $5.7 million has also been requested for combined development of NEXRAD, a next-generation Doppler radar system which will replace NWS' obsolescent radar network.

- In the Environmental Satellite, Data and Information Service, decreases of $27.2 million and increases of $45.9 million are planned. The decreases are the result of plans to reduce the level of improvement in historical climate data, consolidation of seven Satellite Field Service Stations (SFSSs) with colocated WSFOs, and conversion to a one polar satellite system. The increases are due to modifications in satellite launch schedules and to continue a two satellite polar orbiting system.

- Under Supporting Research, a net reduction of $6.561 million is planned. This will be accomplished by reduction of 36 positions and $3.0 million in space environmental research, $2.3 million in meteorological research and $2.0 million in atmospheric climate research. These reductions are proposed as part of NOAA's effort to redirect research activities toward areas which most effectively support NOAA's mission. As part of this redirection, NOAA is also proposing increases for, research and severe storms (+$2 million) and seasonal climate forecasting (+$80 thousand).

In last year's plan, NOAA proposed to finance the aviation weather services ($26.7 million) from the Airport and Airway Trust Fund administered by the Federal Aviation Administration (FAA). However, the FY 1983 Continuing Resolution did not provide funding for aviation weather activities in either the NOAA's or the FAA's appropriation. A study was directed by the conferees concerning the transfer from the FAA Airport and Airway Trust Fund. Pending outcome of the study, NOAA and the FAA were directed to reach agreement on support of the aviation weather program. An interim funding proposal for this activity was transmitted to the Congress in February 1983.

TABLE 3.1
METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH, BY AGENCY
(Thousands of Dollars)

	OPERATIONS			SUPPORTING RESEARCH			TOTAL		
Agency	FY83	FY84	Net Difference	FY83	FY84	Net Difference	FY83	FY84	Net Difference
Agriculture	636	741	+ 105	8,323	8,133	- 190	8,959	8,874	- 85
Commerce	459,005	470,305	+ 11,300	51,734	45,173	- 6,561	510,739	515,478	+ 4,739
Defense	(477,582)	(394,657)	-(82,925)	(83,293)	(102,812)	+(19,519)	(560,875)	(497,469)	-(63,406)
Air Force	417,005	324,478	- 92,527	41,487	46,367	+ 4,880	458,492	370,845	- 87,647
Army	7,560	8,170	+ 610	23,057	36,384	+ 13,327	30,617	44,554	+ 13,937
Navy	53,017	62,009	+ 8,992	18,749	20,061	+ 1,312	71,766	82,070	+ 10,304
Transportation/ Coast Guard	2,114	2,043	- 71	-	-	-	2,114	2,043	- 71
Transportation/ FAA	137,997	132,041	- 5,956	8,068	14,330	+ 6,262	146,065	146,371	+ 306
EPA	500	500	0	5,700	5,700	0	6,200	6,200	0
NASA	898	1,038	+ 140	65,597	59,037	- 6,560	66,495	60,075	- 6,420
TOTAL	1,078,732	1,001,325	- 77,407	222,715	235,185	+ 12,470	1,301,447	1,236,510	- 64,937

Department of Defense (DOD)

The total DOD request for FY 1984 is $497.5 million. Last year's Federal Plan (For FY 1983) showed the DOD funding request for FY 1983 to be $414.9 million. In the present Plan, the FY 1983 funding is now estimated to be $560.9 million. This increase for FY 1983 reflects primarily an up-front appropriation for the Defense Meteorological Satellite Program (DMSP). (See discussion below.) Except for the DMSP item, the comparisons below relate to the funding requests for FY 1984 and the estimated funding for FY 1983 as they are shown in the current Plan.

U. S. Air Force. In the operations area, the funding in FY 1983 is approximately $417.0 million which is about $111.4 million more than was requested in last year's Plan. The greatest increase was for satellite procurement -- an amount of about $118.4 million which is the total up-front appropriation for the DMSP. This increase was partially offset by a reduction of $8.0 million due to realignments and adjustments in the costs for automatic data processing programs.

In FY 1984, operational programs amount to $324.5 million showing a net decrease of $92.5 million from FY 1983. This decrease reflects the end of the multiyear procurement process for the DMSP since the total funding for DMSP is included in the current estimated FY 1983 funding. The program changes by functional categories are as follows:

- For the observing category there will be a net decrease of $111.7 million -- increases totaling $21.6 million for observing equipment and support systems for the DMSP; with a decrease of $133.3 million to reflect the end of the DMSP multiyear procurement, as mentioned previously.

- For the analysis and forecasting category, there will be a net increase of $14.7 million -- most of which will be for the Air Force Global Weather Center (AFGWC) operations.

- For the communications category, there will be a net increase of $13.8 million -- most of which will be for weather communications.

- For General Agency Support, there will be an increase of $1.1 million for a contractual study of an optimum future configuration of the AFGWC.

In the supporting research costs, the funding in FY 1983 is $41.5 million which is approximately $14.5 million less than the budget request reflected in last year's Plan. Most of this change is attributed to a delay in the R&D effort for the DMSP until FY 1985. In FY 1984, supporting research progams amount to $46.4 million -- an increase of $4.9 million above FY 1983 to cover R&D efforts for the Automated Weather Distribution System (AWDS).

U. S. Army. In the operations area, the funding in FY 1983 is approximately $7.56 million which is about the same as the estimate given last year. In FY 1984, the budget request is $8.17 million -- a net increase of $0.61 million to continue the conversion that began last year to a civilian workforce. In the FY 1983-84 time frame, 230 military spaces will be released and filled with civilians.

For supporting research costs in FY 1983, there is about $23.0 million and in FY 1984 approximately $36.3 million. This $13.3 million increase is for converting meteorological observer positions from military to civilian positions, procurement of automated upper-air atmospheric sounding systems in support of R&D efforts, development of remote vertical wind profiler, and procurement of automatic meteorological stations. (See discussion of R&D program in Appendix A.)

U. S. Navy. In the operations area, the funding in FY 1983 is about $53.0 million which is approximately $3.1 million less than was reported in last year's Plan. This reflects updated costs for the DMSP program.

In FY 1984, the U. S. Navy budget request is $62.0 million -- a net increase of $9.0 million above FY 1983. The changes by functional categories are as follows:

- For the observing category, there will be a net increase of $2.9 million -- most of which will be for procurement of DMSP tactical terminals.

- For the analysis and forecasting category, there will be a net increase of approximately $4.0 million for the Fleet Numerical Oceanography Center (FNOC) operations.

- For the communications category, there will be a net increase of about $2.0 million for procurement of weather communications equipment.

- For General Support, there will be an adjustment of about $140 thousand for inflation.

Department of Transportation (DOT)

Program changes from FY 1983 to FY 1984 within DOT are presented for the U. S. Coast Guard and the Federal Aviation Administration.

U. S. Coast Guard (USCG). All of the funding in the USCG is for operations. In FY 1983, the funding level is $2.1 million and in FY 1984 about the same level -- $2.0 million. A breakdown of the FY 1984 operational costs is as follows:

- Observing category -- $522 thousand

- Communications -- $261 thousand

- Dissemination to Users -- $63 thousand

- General Support -- $1.2 million.

Federal Aviation Administration (FAA). In the operations area, the funding level in FY 1983 is approximately $138.0 million -- which is $8.2 million less than it was in last year's Plan. The reduction is due largely to adjustments in costs for air traffic control training.

In FY 1984, the operational programs amount to $132.0 million showing a net decrease of about $6.0 million. The significant changes by functional categories are described below:

- For the observing category, there will be a net reduction of $5.3 million -- decreases in requirements for weather radar displays and weather data information services.

- For the communications category, there will be a slight increase of $1.1 million for increased operating costs.

- For General Support, there will be an increase of about $1.8 million for maintenance and training.

In the supporting research costs, the funding in FY 1983 is $8.1 million which is approximately $4.9 million above the amount reported last year. Most of this increase is due to increased cost for R&D efforts across the board. In FY 1984 the funding level will be $14.3 million -- an increase of $6.3 million above FY 1983 to maintain the level of continuing research to improve aviation weather service to the Nation.

Environmental Protection Agency (EPA)

EPA is continuing its development and validation of air quality models for pollutants. The research will focus on both urban and regional models and will be used to develop pollution control strategies. The planned funding level in FY 1983 and FY 1984 is $6.2 million.

National Aeronautics and Space Administration (NASA)

The NASA planned funding level for FY 1983 is $66.5 million. In FY 1984, the funding level will be $60.1 million. This decrease of $6.4 million reflects NASA's phasing out of operational sensors for weather satellites, and completion of the Earth Radiation Budget Experiment Satellite Development with launch scheduled for 1984. In the future, NASA will concentrate its research efforts on climatic change studies; mesoscale circulations using remote sensing data; and general circulation models using satellite data.

AGENCY OPERATIONAL COSTS BY FUNCTION

Table 3.2 shows how the agencies plan to obligate their funds for the five major operational functions involved in meteorological service operations. Brief descriptions of the activities included in each of these major functions are provided below.

Observations. This function involves obtaining the data that underlie all weather forecasts and warnings. The observing function is divided into five program elements for planning and coordination: surface, upper air, weather reconnaissance, weather radar, and operational environmental satellite observing programs.

Analyses and Forecasts. This function involves centralized production of manual and computerized analyses of metorological data as well as projections of the future states of the atmosphere and accompanying weather phenomena. This function is divided into three parts: analyses and forecasts on a global and hemispheric basis; products tailored for specific areas or user groups; and specific weather phenomena, such as hurricanes and severe thunderstorms.

TABLE 3.2
AGENCY OPERATIONAL COSTS, BY FUNCTION
(Thousands of Dollars)

AGENCY	Observations		Analyses and Forecasts		Communications		Dissemination to Users		General Agency Support		Total	
	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84
Agriculture	250	250	50	50	-	-	300	350	36	91	636	741
Commerce	223,069	179,319	132,182	154,438	16,427	17,619	44,097	70,476	43,230	48,453	459,005	470,305
Defense	(263,943)	(152,736)	(54,728)	(73,756)	(38,341)	(44,510)	(52,070)	(53,013)	(68,500)	(70,642)	(477,582)	(394,657)
Air Force	251,248	136,746	35,812	51,157	30,837	35,093	47,077	47,768	52,031	53,714	417,005	324,478
Army	7,235	7,524	-	-	-	-	-	-	325	646	7,560	8,170
Navy	5,460	8,466	18,916	22,599	7,504	9,417	4,993	5,245	16,144	16,282	53,017	62,009
Transportation/ Coast Guard	548	522	-	-	274	261	63	63	1,229	1,197	2,114	2,043
Transportation/ FAA	20,168	14,842	-	-	42,559	43,619	45,080	46,089	30,190	27,491	137,997	132,041
EPA	-	-	500	500	-	-	-	-	-	-	500	500
NASA	125	230	300	318	62	65	-	-	411	425	898	1,038
TOTAL	508,103	347,899	187,760	229,062	97,663	106,074	141,610	169,991	143,596	148,299	1,078,732	1,001,325

Communications. This involves the movement of very large amounts of data and information from the observation sites to the processing centers and then disseminating products to users.

Dissemination to Users. This function represents the final step in preparing and delivering weather service products to the users. The field offices of DOC and DOD and the flight service stations of DOT are the principal program elements involved.

General Agency Support. This function involves the planning, training, maintenance, and management activities common to any large dispersed activity. The general support function is divided into internal support and planning, engineering and mission-related work, maintenance of equipment and facilities, training of personnel, and overall program management.

Table 3.2 shows that the agencies devote about 48 percent of their resources to observations on a sustaining basis. The principal changes year-to-year are associated with cyclic variations in satellite procurements and with costs for new equipment such as automatic weather observing stations and weather radars. Approximately 15 percent is devoted to analyses and forecasts where the major year-to-year changes are the result of replacing the computers that are the keystone of the operations. Communications costs, comprising about nine percent of the total program, are usually stable year-to-year, reflecting the long-term nature of communications systems planning, engineering and operation. The dissemination to users function is also usually stable from year-to-year at about 14 percent because the field office structures are not subject to large changes. General agency support requiring the remaining 14 percent is subject to some significant year-to-year variations, especially in maintenance and training activities.

AGENCY SUPPORTING RESEARCH COSTS BY FUNCTION

Table 3.3 shows how the agencies plan to obligate their funds for supporting research in the four functional areas used for planning and coordinating programs.

The supporting research functions do not differ greatly from those discussed previously for operational programs. The observation and dissemination functions are identical and the "description and prediction" function equates to "analyses and forecasts." The research function of "systems and support" covers the development and engineering research work related to maintenance, training, and engineering operations.

Supporting research programs characteristically are stable year-to-year unless a major project is initiated or terminated by one or more of the agencies.

METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH BY SERVICE

Table 3.4 shows how the agencies plan to obligate operational funds for basic and specialized meteorological services; Table 3.5 shows the corresponding data for supporting research. Table 3.4 shows that the operational costs of the total Federal program are about evenly split between basic services and the

TABLE 3.3
AGENCY SUPPORTING RESEARCH COSTS, BY FUNCTION
(Thousands of Dollars)

AGENCY	Observations		Description and Prediction		Dissemination		Systems and Support		Total	
	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84
Agriculture	-	-	3,000	3,000	500	500	4,823	4,633	8,323	8,133
Commerce	17,072	14,852	32,747	28,393	1,915	1,928	-	-	51,734	45,173
Defense	(48,164)	(59,042)	(19,190)	(21,273)	(950)	(1,121)	(14,991)	(21,376)	(83,295)	(102,812)
Air Force	35,000	39,368	6,163	6,623	259	306	65	70	41,487	46,367
Army	5,174	11,125	6,146	7,289	490	600	11,247	17,370	23,057	36,384
Navy	7,990	8,549	6,879	7,361	201	215	3,679	3,936	18,749	20,061
Transportation/ Coast Guard	- NOT APPLICABLE-									
Transportation/ FAA	293	610	239	219	3,561	7,040	3,975	6,461	8,068	14,330
EPA	-	-	5,700	5,700	-	-	-	-	5,700	5,700
NASA	45,575	32,000	18,975	26,000	-	-	1,047	1,037	65,597	59,037
TOTAL	111,104	106,504	79,849	84,585	6,926	10,589	24,836	33,507	222,715	235,185

TABLE 3.4
AGENCY OPERATIONAL COSTS, BY SERVICE
(Thousands of Dollars)

AGENCY	Basic		Aviation		Marine		Agriculture and Forestry		General Military		Other		Total	
	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84
Agriculture	-	-	-	-	-	-	636	741	-	-	-	-	636	741
Commerce	420,286	437,046	26,700	26,700	4,282	3,438	4,585	0	-	-	3,152	3,121	459,005	470,305
Defense	(176,710)	(76,498)	(194,375)	(202,327)	(10,937)	(8,904)	-	-	(63,087)	(68,324)	(32,473)	(38,604)	(477,582)	(394,657)
Air Force	169,345	67,755	179,596	182,951	-	-	-	-	41,410	42,082	26,654	31,690	417,005	324,478
Army	-	-	-	-	-	-	-	-	7,560	8,170	-	-	7,560	8,170
Navy	7,365	8,743	14,779	19,376	10,937	8,904	-	-	14,117	18,072	5,819	6,914	53,017	62,009
Transportation/ Coast Guard	1,476	1,414	-	-	638	629	-	-	-	-	-	-	2,114	2,043
Transportation/ FAA	12,175	12,384	125,822	119,657	-	-	-	-	-	-	-	-	137,997	132,041
EPA	-	-	-	-	-	-	-	-	-	-	500	500	500	500
NASA	-	-	-	-	-	-	-	-	-	-	898	1,038	898	1,038
TOTAL	610,647	527,342	346,897	348,684	15,857	12,971	5,221	741	63,087	68,324	37,023	43,263	1,078,732	1,001,325

TABLE 3.5
AGENCY SUPPORTING RESEARCH COSTS, BY SERVICE
(Thousands of Dollars)

AGENCY	Basic		Aviation		Marine		Agriculture and Forestry		General Military		Other		Total	
	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84
Agriculture	-	-	-	-	-	-	8,323	8,133	-	-	-	-	8,323	8,133
Commerce	50,491	43,915	-	-	1,223	1,240	20	18	-	-	-	-	51,734	45,173
Defense	(6,600)	(7,062)	(2,350)	(2,514)	(6,150)	(6,581)	-	-	(68,193)	(86,655)	-	-	(83,293)	(102,812)
Air Force	-	-	-	-	-	-	-	-	41,487	46,367	-	-	41,487	46,367
Army	-	-	-	-	-	-	-	-	23,057	36,384	-	-	23,057	36,384
Navy	6,600	7,062	2,350	2,514	6,150	6,581	-	-	3,649	3,904	-	-	18,749	20,061
Transportation/ Coast Guard	- NOT APPLICABLE -													
Transportation/ FAA	-	-	8,068	14,330	-	-	-	-	-	-	-	-	8,068	14,330
EPA	-	-	-	-	-	-	-	-	-	-	5,700	5,700	5,700	5,700
NASA	64,700	58,000	-	-	-	-	-	-	-	-	897	1,037	65,597	59,037
TOTAL	121,791	108,977	10,418	16,844	7,373	7,821	8,343	8,151	68,193	86,655	6,597	6,737	222,715	235,185

specialized services. The definitions of specialized and basic services are provided below.

Specialized Services

For purposes of Federal planning and coordinating, Specialized Services are:

- Aviation Meteorological Services: Those services and facilities established to meet the requirements of general, commercial and military aviation. Civil programs are included that are directly related to services solely for civil and military programs in support of fixed and rotary wing aircraft and medium or long-range missile operations.
- Marine Meteorological Services: Those services and facilities established to meet the requirements of Commerce and Defense on the high seas, coastal and inland waters and for boating activities in coastal and inland waters. The civil programs which are directly related to services solely for marine uses and military programs supporting fleet, amphibious and sea-borne units (including carrier-based aviation and fleet missile systems) are included.
- Agriculture and Forestry Meteorological Services: Those services and facilities established to meet the requirements of the agricultural industries and Federal, State and local agencies charged with the protection and maintenance of the Nation's forests. The agricultural, large-area crop inventory programs and fruit-frost programs of the Department of Commerce are included.
- General Military Meteorological Service: Those services and facilities established to meet the requirements of military user commands and their component elements. Programs and services which are part of Basic, Aviation, Marine or Other Specialized Services are not included here.
- Other Specialized Meteorological Services: Those services and facilities established to meet requirements of user agencies or groups not incuded in the preceding categories, such as support to civil and military programs involving space operations and support to Federal, State and local governmental agencies responsible for dealing with urban air pollution.

Basic Services

Basic services includes the programs and activities that do not fall under one of the specialized services identified above. In general, the products from the basic services are not useful for the operational needs of users. Basic services provides products that meet the common needs of all users and includes the products needed by the general public in their every day activities and for the protection of lives and property.

AGENCY PERSONNEL ENGAGED IN WEATHER OPERATIONS

Table 3.6 shows how agency staff resources are distributed among the five functions involved in weather operations. Overall, agency staff resources for

TABLE 3.6

AGENCY PERSONNEL ENGAGED IN WEATHER OPERATIONS, BY FUNCTION

AGENCY		Observations		Analyses and Forecasts		Communications		Dissemination to Users		General Agency Support		Total	
		FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84	FY83	FY84
Agriculture		- NOT APPLICABLE -											
Commerce	***	1,438	1,561	2,322	2,170	155	151	1,148	1,043	856	859	5,919	5,784
Defense		(2,467)	(2,445)	(1,687)	(1,710)	(745)	(736)	(2,490)	(2,490)	(2,046)	(2,056)	(9,435)	(9,437)
Air Force		2,031	2,009	919	942	540	531	2,227	2,227	1,711	1,711	7,428	7,420
Army		364	364	-	-	-	-	-	-	11	21	375	385
Navy		72	72	768	768	205	205	263	263	324	324	1,632	1,632
(Navy)	*	-	-	12	12	4	4	-	-	4	4	20	20
Transportation/	***	34	32	-	-	17	16	4	4	52	51	107	103
Coast Guard	**	-	-	-	-	-	-	-	-	14	14	14	14
Transportation/ FAA		315	311	-	-	816	812	1,247	1,189	633	591	3,011	2,903
EPA		-	-	13	13	-	-	-	-	-	-	13	13
NASA	***	1	0	6	0	1	0	-	-	4	2	12	2
TOTAL		4,255	4,349	4,040	3,905	1,738	1,719	4,889	4,726	3,609	3,577	18,531	18,276

---

*Funded by other agencies
**Staff-years funded by other agencies
***Staff-years (full-time equivalent)

FY 1984 total 18,276. This is a decrease of 255 from the 18,531 reported for FY 1983. This decrease is associated with the DOC's conversion of the WSFOs and reduction in the number of regional headquarters and adjustments in DOT's FSS operations.

Among the functions, "Dissemination" requires approximately 26 percent of all staff resources. This reflects the large number of field offices operated by the Department of Commerce, Defense and Transportation, with many of these offices operating around-the-clock to serve the general public, military needs and the aviation industry.

The "Observations" function requires about 23 percent and "General Agency Support" accounts for about 19 percent of the staff resources for weather operations. Both are labor-intensive, particularly maintenance of increasingly sophisticated equipment and around-the-clock observations for forecasts, warnings and aircraft operations.

"Analyses and Forecasts" consume approximately 22 percent of the Federal staff resources for weather operations. This function, while requiring a substantial number of personnel, makes extensive use of computers and related automated processing systems to prepare a wide array of products employed by field offices to satisfy the needs of the public and specialized users of weather information. A significant portion of these staff resources are devoted to preparing and maintaining the computer programs necessary to produce new and more effective products.

The "Communications" function requires about 10 percent of the staff resources, the smallest percentage of any of the functions. This reflects the fact that communication has become less labor-intensive over the years as modern equipment came into use. It is important to note that the high percentage of the total Department of Transportation (Federal Aviation Administration) staff resources devoted to "Communications" is attributable to operations of major communications systems which support the other agencies as well as the FAA.

INTERAGENCY FUND TRANSFERS

Federal agencies transfer funds to other agencies to pay for services that the receiving agencies can perform more efficiently and effectively. Table 3.7 shows the interagency fund transfers for FY 1983. The total amount transferred is $138.8 million for operations and $5.5 million for supporting research. While specific amounts may vary from year-to-year, depending upon agency needs, the pattern shown in this table is essentially stable.

Department of Commerce. The Department of Defense will be reimbursed $7.0 million of which $6.8 million is for airborne weather reconnaissance of tropical cyclones and winter storms and $0.2 million for logistical support and upper air observations. The National Aeronautics and Space Administration will be reimbursed $119.8 million for costs related to procurement and launch of NOAA operational spacecraft.

Department of Defense. The Department of Commerce will be reimbursed a total of $3.4 million for data acquisition and archiving, upper air expendables, automated wind finding radars, and support of the Office of the Federal Coordinator under the provisions of OMB Circular A-62.

TABLE 3.7
INTERAGENCY FUND TRANSFERS FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH, FY 1983
(Thousands of Dollars)

Agency		FY 83 Funds	
Transferred from:	Transferred to:	Operations	Research
Commerce	DOD	$ 7,000	$ -
	DOI	4	-
	DOS	99	-
	NASA	119,775*	-
Defense	DOC	3,359	95
	DOE	-	120
	DOT	21	-
	NASA	-	88
Transportation	DOC(NOAA)	5,660	2,000
	NASA	-	555
NASA	DOC	335	-
	DOD(USAF)	292	-
	NSF	-	35
EPA	DOC	-	2,600
DOE	DOC	2,246	-
	TOTAL	$138,791	$5,493

---

*Polar spacecraft and launching ($44,418)
Geostationary spacecraft and launching ($67,757)
Environmental satellite services ($7,600)

Department of Transportation. The Department of Commerce will be reimbursed $7.66 million principally for meteorological support at Center Weather Service Units located with most Air Route Traffic Control Centers, research and development on meteorological equipment and prediction technology to support flight safety, meteorological training support, AM Morning TV Weather Service, and for support of the Office of the Federal Coordinator for Meteorology.

National Aeronautics and Space Administration. The Department of Defense will be reimbursed $292 thousand and the Department of Commerce $335 thousand, principally for meterological support to the space-shuttle operations.

Environmental Protection Agency. Research and development support related primarily to air quality standards will require transfer of $2.6 million to the Department of Commerce.

Department of Energy. To support the Weather Service Support Office at the Nevada Nuclear Test Site, $2.24 million is transferred to the Department of Commerce.

LOCATIONS BY OBSERVING TYPE

Table 3.8 indicates that there are approximately 4,000 locations or platforms at which the Federal agencies make weather observations. About half of these are under the NWS Merchant Ship Cooperative Program. Included are NOAA's data buoy locations: Atlantic Ocean (5); Gulf of Mexico (3); Great Lakes (8); and Pacific Ocean (8). In addition, NOAA has placed observing equipment on eight Department of Interior platforms (buoys or offshore platforms). NOAA also receives observational data from seven EXXON platforms in the Bering Sea. The status and capability of data buoys can be obtained from the Director, NOAA Data Buoy Office, NSTL Station, MS 39529.

TABLE 3.8
LOCATIONS BY OBSERVATION FUNCTION
FY 1983 and FY 1984

Observation Function	Agency	FY 1983	FY 1984
Surface (Land)	Commerce	424	424
	Commerce (Automatic)	123	123
	Defense (U.S.)	156	156
	Defense (Overseas)	78	78
	Transportation (FAA)	383	373
	Transportation (Coast Guard)	128	122
	NASA	1	1
Surface (Marine)	Commerce (MSCP)1/	2,000	2,000
	Commerce (Buoys)	24	24
	Transportation (CG Ships)	80	80
	Defense (Ships w/met personnel)	30	30
Upper Air (Rocket)	NASA	1	1
	Defense	2	1
Upper Air (Balloon)	Commerce (U.S.)	89	89
	Commerce (Overseas)	45	45
	Defense Fixed (U.S. & Overseas)	43	43
	Defense (Ships)	28	28
	Defense Mobile (U.S. & Overseas)	15	10
	NASA (U.S.)	1	1
	Transportation (Coast Guard)2/	18	18
Weather Radar	Commerce (U.S.)	128	128
	Commerce (At FAA Radars)	22	22
	Defense (U.S. & Overseas)	115	115
	Defense (Remote displays)	31	28
Weather Reconnaissance	Defense (No. of aircraft)	20	20
	TOTAL	3,985	3,960

1/ Merchant Ship Cooperative Program
2/ Inactive but available for use

SECTION 4

NATIONAL CLIMATE PROGRAM

The National Climate Program was established in 1978 by Public Law 95-367 as a means to assist the country and the world "to understand and respond to natural and man-induced climate processes and their implications." The program, one of research and applications, requires coordinated efforts among the many agencies that develop climate understanding and knowledge, that use climate information in accomplishing their particular mission, and that are responsible for the active dissemination of climate information to promote its utility to Government, industry and the public.

The National Climate Program Act requires that the Office of Management and Budget (OMB) review the agencies' requests for climate activities as an integrated, coherent, multiagency request. OMB Circular A-11 requires agencies to forward their climate budget data to the National Climate Program Office (NCPO) in parallel with submission to OMB. NCPO then compiles the data and prepares an analysis of agency requests in terms of the requirements of a Five Year Plan and submits the analysis directly to OMB. The material provided in this section of the Federal Plan focuses primarily on new initiatives for FY 1984. It is for information only and is based upon data available to the NCPO as of January 1983. Specific questions regarding these data should be addressed to the National Climate Program Office, NOAA, Rockville, Maryland 20852.

The Climate Program has some overlap with the meteorological programs reported in other sections of this Plan, especially with regard to observations. Those activities that cannot be uniquely or exclusively identified as "climate" may also be reported in the other sections of this Plan. As a result, "climate" funding cannot be added to the "meteorological" programs for a grand total since some activities would be double counted.

THE BASE PROGRAM

The distribution of resources by agency for climate research and services for FY 1982 through FY 1984 is shown in Table 4.1. In Table 4.2, the existing base program is subdivided into the major categories of the National Climate Program (NCP). Both tables show that in FY 1984 there will be a slight decrease in total program funding. The DOC/NOAA budget shows a $1.0 million increase from FY 1982 to FY 1983. This is due to a revision of NOAA's budget which now includes certain overhead costs not previously included in past analyses. The FY 1983 NOAA base program budget is therefore larger in dollars amount than FY 1982 but is actually reduced in terms of total effort. For the Program as a whole, there continues to be a high degree of coordination and joint funding in areas of mutual interest among agencies.

The NCPO has made an analysis of trends in the base program over the past several years and compared the range of budget levels anticipated in the Five Year Plan (1980) with base program budget requests for fiscal years 1982-1984. For most categories, the FY 1982-1984 budget requests are within the range anticipated by the Five Year Plan. The major exception is the area of data management. The Plan anticipated that about 13% of the total effort would be directed to this area whereas only about 8% has been requested. The NCPO identifies this as a potential erosion of data management capabilities -- particularly in NOAA -- on which other elements of the program strongly depend.

Data management is a particularly important area to the NCP and to the Nation as a whole. Data archives exist which are a valuable national resource and should be maintained at levels consistent with modern technology. With recent advances in communication and information systems, the data management aspect of the NCP is at the beginning of a technological revolution. Opportunities in these areas must be evaluated in light of the National Climate Program requirements and OMB advised on future needs.

CROSSCUT REVIEW OF THE NATIONAL CLIMATE PROGRAM, FY 1984 BUDGET

Impact Assessment

Agency requests for Climate Impact Assessment will total $21.3 million, a slight increase over the planned level of effort in FY 1983. The principal programs are in U.S. Department of Agriculture (USDA) to determine the impacts of climate on food, fiber, and livestock production and in the Department of Energy (DOE) for studies associated with possible impacts of increased carbon dioxide (CO_2) levels in the atmosphere. The DOE effort is focused on developing and assessing reliable information for the 1984 "Interim Assessment Report," a definitive statement up to that time, in the issues associated with increasing levels of atmospheric CO_2. DOE leads the multiagency effort in this area.

The National Oceanic and Atmospheric Administration (NOAA) conducts studies of climate and fisheries productivity and of agricultural crop yield models. The Bureau of Reclamation of the Department of Interior (DOI) conducts studies of climatic impact on water resources management (watershed and river basin management and development, etc.) for the western United States which are large semiarid regions.

Climate System Research

The FY 1984 total request for Climate System Research will be $61.0M. The largest request is for the National Science Foundation (NSF) which supports a broad program in nearly all activities of climate research (atmospheric and oceanic studies, earth sciences, paleoclimatology, etc.). All of the NSF funding supports extramural academic research. NOAA's research is largely focused on oceanic influences on important features of large scale climate and includes an increase of about $2.4M for a new initiative to support the Ocean-Atmosphere Climate Interaction Studies (OACIS) Program.

DOI maintains a modest paleoclimate research program to describe long term climate variations. DOE research is predominantly in support of the CO_2 program including studies of the global carbon cycle, improving climate models, and determining effects of increased CO_2 on vegetation. NOAA, NSF, USDA and DOI have active research programs in support of the national program on CO_2 and climate.

Observations

The National Aeronautics and Space Administration (NASA) FY 1984 request for the observations subprogram is primarily to support the development of the satellite systems for the Earth Radiation Budget Experiment. This experiment will measure the incoming and outgoing (reflected and emitted) radiation in an attempt to relate variability in the radiation budget to variability in climate. Such measurements can only be carried out from space. NASA is also supporting the development of a satellite borne stratospheric monitoring sensor to give information on ozone levels and the ultraviolet spectrum of incoming solar radiation.

The NOAA request will mainly support the Geophysical Monitoring for Climatic Change (GMCC) program which includes ground-based measurement of ozone and CO_2, two key questions of very active interest. USDA measures snow pack in order to forecast snow melt runoff for irrigation. The declining level of the NSF request reflects a plan for no ocean drilling during 1984.

Data Management

All of the agencies have data management responsibilities for the measurements they make. In addition, certain measurements taken for other purposes (e.g., weather) are retained for use in climate studies and applications. Thus, Table 4.2 includes data management funds for agencies which do not make direct climate observations.

NOAA has overall civil sector responsibility for providing climate information; thus, it has the largest program. Department of Defense also has a very large program but has grouped its funding under Information Services. The Department of Interior program is for the maintenance of a precipitation climatology partly related to its precipitation enhancement efforts.

Diagnosis and Projection

The NOAA request is to support its Climate Analysis Center which provides monthly and seasonal climate forecasts, maintains a climate diagnostic data base, conducts large scale climate diagnostic studies, and cooperates with USDA in operating the Joint Agricultural Weather Facility. The funds shown for USDA support snow melt runoff projections. NSF funds for diagnostic studies support climate prediction research and are reported in the Climate System Research category.

Information Services

These funds support the development and dissemination of climate information to end users -- primarily to the public but also to DOD field commanders and planners. DOD has lumped most of its request for Data Management and Diagnosis and Projection into this category as the funds support facilities such as the U.S. Air Force (USAF) Environmental Technical Applications Center which manages the data, conducts engineering and applied climatological studies, and forwards the resulting information to the requester.

TABLE 4.1

CLIMATE FY 1984 BUDGET REQUESTS BY AGENCY

(Millions of Dollars)

	FY82 Actual	FY83 Planned	FY84 Request
USDA	15.8	16.1	16.3
DOC/NOAA	30.3	31.3	31.9
DOD	10.2	11.4	12.2
DOE	13.5	9.1	12.5
DOI	4.8	3.4	3.1
NASA	31.9	33.9	26.0
NSF	34.7	36.9	38.3
TOTAL	141.2	142.1	140.3

TABLE 4.2

CLIMATE FY 1984 BUDGET REQUESTS BY SUBPROGRAMS AND AGENCY

(Millions of Dollars)

	FY82 Actual	FY83 Planned	FY84 Request
IMPACT ASSESSMENT			
Agriculture	11.6	11.9	12.1
Commerce (NOAA)	1.8	1.8	1.8
Defense	-	-	-
Energy	4.5	3.2	5.2
Interior	0.9	1.1	1.2
NASA	-	-	-
NSF	0.7	0.9	1.0
Subtotal	(19.5)	(18.9)	(21.3)
CLIMATE SYSTEM RESEARCH			
Agriculture	-	-	-
Commerce (NOAA)	10.4	10.4	12.8
Defense	2.0	2.0	2.5
Energy	9.0	5.9	7.3
Interior	2.3	0.7	0.6
NASA	2.0	5.2	5.2
NSF	28.5	30.0	32.6
Subtotal	(54.2)	(54.2)	(61.0)
OBSERVATIONS			
Agriculture	1.5	1.5	1.5
Commerce (NOAA)	7.4	8.5	6.9
Defense	-	-	-
Energy	-	-	-
Interior	-	-	-
NASA	29.1	28.1	20.2
NSF	4.9	5.2	2.7
Subtotal	(42.9)	(43.3)	(31.3)

TABLE 4.2 - cont'd.

	FY82 Actual	FY83 Planned	FY84 Request
DATA MANAGEMENT			
Agriculture	0.5	0.4	0.4
Commerce (NOAA)	6.5	6.5	6.5
Defense	0.7	0.7	0.7
Energy	-	-	-
Interior	1.6	1.6	1.3
NASA	0.8	0.6	0.6
NSF	0.6	0.8	0.8
Subtotal	(10.7)	(10.6)	(10.3)
DIAGNOSIS AND PROJECTION			
Agriculture	1.6	1.7	1.7
Commerce (NOAA)	1.1	1.0	0.7
Defense	-	-	-
Energy	-	-	-
Interior	-	-	-
NASA	-	-	-
NSF	-	-	1.2
Subtotal	(2.7)	(2.7)	(3.6)
INFORMATION SERVICES			
Agriculture	0.6	0.6	0.6
Commerce (NOAA)	2.0	2.0	2.0
Defense	7.5	8.7	9.0
Energy	-	-	-
Interior	-	-	-
NASA	-	-	-
NSF	-	-	-
Subtotal	(10.1)	(11.3)	(11.6)
NCPO	1.1	1.1	1.2
GRAND TOTALS	141.2	142.1	140.3

NOTE: A blank row means the Agency has no program in that area.

SECTION 5

WORLD WEATHER PROGRAM

The Department of Commerce (DOC) was designated by the President, following Senate Concurrent Resolution 67 (1968), to be the lead agency in coordinating the U. S. participation in the World Weather Program (WWP), including the Global Atmospheric Research Program (GARP). Previously, DOC has published separate WWP Plans. Beginning with this edition of the Federal Plan for Meteorological Services and Supporting Research, this section on the WWP is included and will obviate the need for two separate reports. This section also includes international cooperative activities not under the WWP. Coordination of these activities and preparation of this section is done by the Working Group on World Weather Program (WG/WWP) of the Committee on Basic Services within the Federal coordination mechanism.

GOALS AND ORGANIZATION OF THE WORLD WEATHER PROGRAM

The goals of the World Weather Program (WWP) are to extend the time, range and scope of weather prediction and to understand the physical basis of climate and of climatic changes. The ability of the United States and other nations to use their existing scientific capability to understand the climate and to increase their weather predicting skills is limited by the lack of global weather data. Available weather data is barely adequate over 20 percent of the earth while the remaining 80 percent, mostly over the oceans, remains inadequately observed.

Development of the technology and the systems to obtain these observations, especially over the oceans, presents formidable problems. However, with the use of aircraft, satellite, ships, radar, anchored and drifting buoys, and balloons, a system can be developed that will be able to observe and collect comprehensive daily data about the atmosphere of the entire globe. This system is too complex to be implemented by a single nation. This has been clearly recognized by the leaders of many nations whose international cooperation in meteorology has been a tradition for more than a century. The continuing need for international cooperation prompted the President of the United States to propose to the United Nations (UN) in 1961 the establishment of an international effort in weather prediction. The United Nations responded by calling upon the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU) to develop measures to improve weather forecasting capabilities and to advance knowledge of the basic physical forces that determine climate.

The WMO is a specialized agency created by the UN to facilitate international cooperation in the fields of meteorology and hydrology and has grown to 152 Members. The WMO responded to the UN request with the concept of the World Weather Watch (WWW), an operational system to bring the global atmosphere under improved surveillance and to provide for the rapid collection and exchange of weather data as well as for the dissemination of weather products from centralized processing centers. WMO and the ICSU clearly recognized the need for intensified research concerned with the physical processes governing atmospheric motion and their formulation in mathematical models. To meet this need, the WMO established the Global Atmospheric Research Program (GARP).

In addition to WWW and GARP, DOC through the National Oceanic and Atmospheric Administration (NOAA) is involved in two other major cooperative international programs. These are the Sahel Agrometeorological and Hydrological Program and the Bangladesh Disaster Alert/Agro-Climatic/Environmental Monitoring Project. Funds for NOAA's participation and support of these programs are provided by the Department of State (DOS) Agency for International Development (AID).

The responsibilities of U. S. Federal agencies in the WWP follow:

Department of Commerce: Represents the U. S. at WMO and ICSU and provides the focal point (NOAA) to coordinate our nation's efforts in these international programs, implements those service improvements in the existing international weather system for which the U. S. accepts responsibility, and develops new technology as related to its responsibilities.

Department of State: Maintains relations with developing nations and through the WMO assists developing nations in improving their national weather services; and develops appropriate multilateral and bilateral arrangements to further international participation.

National Science Foundation: Stimulates research on the general circulation of the atmosphere among nongovernmental scientists, develops new technology for observing the atmosphere, and promotes the education and training of atmospheric scientists.

Department of Defense: Although the mission of the Department of Defense (DOD) weather services is basically internal, the nature of DOD's operations is global. As such, the observation, telecommunication and data processing programs of the military weather services provide significant indirect support to the WWW through DOD's interface with NOAA's National Weather Service (NWS). Information from the research and development activities of these services is exchanged routinely with other similar national agencies and is often presented at national forums.

Department of Transportation: The U. S. Coast Guard provides personnel to support the DOC/NOAA Data Buoy Office (NDBO) in developing, operating and evaluating data buoy systems. Coast Guard cutters and aircraft provide operational support to deploy, service, and retrieve buoys built for test or operational purposes.

National Aeronautics and Space Administration: Performs research and develops space technology required for an economical global weather system.

THE WORLD WEATHER WATCH

The World Weather Watch (WWW) is an integrated system which functions on three levels: global, regional and national. The WWW is divided into three elements that are closely linked and interdependent: Global Observing System (GOS), Global Data Processing System (GDPS), and Global Telecommunications System (GTS).

These elements are supported by a monitoring and operational information system which provides the status of the WWW to WMO Members. An additional supporting activity arranges for the exchange of knowledge and methodology, and assists Members in the planning, design, establishment and operation of WWW facilities and services.

Global Observing System (GOS)

The GOS is a coordinated system of methods, techniques, and facilities for making weather observation on a worldwide scale. It is a composite system containing surface-based and space-based (satellite) subsystems. The main elements of the surface-based subsystem are:

- Regional basic synoptic networks, manned and automatic, for both surface and upper-air observations.
- Fixed sea stations, which is composed of ocean weather stations, fixed and anchored platform stations, island stations and coastal stations.
- Mobile sea stations, including moving ships and drifting buoys.
- Aircraft Meteorological Stations, includes three automated aircraft reporting systems: Aircraft to Satellite Data Relay (ASDAR); Aircraft Integrated Data Systems (AIDS); and ARINC Communications, Addressing and Reporting System (ACARS).

Other elements are:

Aeronautical Meteorological Stations
Research and Special Purpose Vessels
Climatological Stations
Agricultural Meteorological Stations
Weather Radar Stations
Meteorological Reconnaissance Aircraft
Solar Radiation Stations
Atmospheric Detection Stations
Meteorological Rocket Stations
Ozone Stations
Background Pollution Stations
Tide Gauge Stations

The space-based subsystem (satellite) has become increasingly important in supporting meteorological and hydrological predictions and warnings. When completed, the following types of satellites will constitute the space-based subsystem:

a. Near-polar-orbiting satellites will consist of satellites operated by the United States and the Soviet Union. Both countries plan to have two operational satellites in orbit at any time during the period 1984-87. At present, the system is composed of the Soviet's METEOR/Model 12 and the United States' NOAA/TIROS-N model satellites.

b. Geostationary satellites will consist of six satellites at fixed positions over the equator. Their longitude and operators are: 140°E (Japan), 74°E (India), 70°E (USSR), 0°E (European Space Agency), 75°W (USA), 135°W (USA).

Each system is composed of one or more satellites and a ground segment. The satellites provide meteorological imagery, vertical temperature and humidity profiles; observational data collection; and dissemination of weather information. The ground segment is composed of receiving and processing stations for satellite signals and data from Data Collection Platforms (DCPs). The ground segment also provides information and products for further distribution by the Global Telecommunications System (GTS).

Global Data Processing System (GDPS)

The purpose of the GDPS is to coordinate the Members' data processing activities in order to make available all processed information required for both real-time and non-real time applications. The GDPS produces products and processed information, based on recent advances in atmospheric science, using powerful numerical computer methods. Each Member, employing suitable transmission techniques through the GTS, has real-time access to GDPS products which allow the Members to benefit from their participation in the WWW. Access to information in the non-real-time mode allow an exchange of delayed information for the Members to meet their requirements for observational and processed information.

The GDPS is organized as a three-level system. It consists of World Meteorological Centers (WMCs) and Regional Meteorological Centers (RMCs) at the global and regional levels, respectively, and the National Meteorologicial Centers (NMCs) which carry out GDPS functions at the national level. In general, real-time functions of the system involve preprocessing of data, analysis and prognosis, including derivation of appropriate meteorological parameters. The non-real-time functions include collection, quality control, storage and retrieval, as well as cataloging of observational data and processed information for operational and special applications, and for research.

WMCs are located in Melbourne, Moscow and Washington; they provide products used for general short-, medium- and long-range weather forecasts. Melbourne also provides additional forecast products for the Southern Hemisphere.

The RMCs are located at Algiers, Algeria; Antananarivo, Malagasy; Beijing, People's Republic of China; Bracknell, England; Brasilia, Brazil; Buenos Aires, Argentina; Cairo, Egypt; Dakar, Senegal; Darwin, Australia; Jeddah, Saudi Arabia; Khabarovsk, USSR; Lagos, Nigeria; Melbourne, Australia; Miami, USA; Montreal, Canada; Moscow, USSR; Nairobi, Kenya; New Delhi, India; Norrköping, Sweden; Novosibirsk, USSR; Offenbach, Germany; Rome, Italy; Tashkent, USSR; Tokyo, Japan; Tunis, Tunisia; and Wellington, New Zealand. These centers provide regional products used for short- and medium-range forecasting of small-, meso- and large-scale meteorological systems by WMCs. Products of RMCs can be used by Members at the national level for further processing or interpretation to provide assistance or service to users.

Global Telecommunications System (GTS)

The GTS was established to provide communication services for the collection, exchange and distribution of observational data and processed information from the WMCs and RMCs operating within the GDPS of the WWW, to meet the needs of Members for operational and research purposes which involve real-time or quasi-real-time exchange of information. The GTS also supports other WMO programs, joint programs with other international organizations, and environmental programs as decided by the WMO Congress.

The GTS is organized on three levels:

a. The Main Trunk Network (MTN);
b. The Regional Meteorological Telecommunication Networks (RMTN);
c. The National Meteorological Telecommunication Networks (NMTN).

The GTS is supported by telecommunication functions of the WMCs, Regional Telecommunications Hubs (RTHs), RMCs, and NMCs.

The MTN links the WMCs at Melbourne, Moscow, and Washington with the RTHs at Beijing, Bracknell, Brasilia, Buenos Aires, Cairo, Nairobi, New Delhi, Offenbach, Paris, Prague, Tokyo, and Jeddah. The MTN provides a communication function between the WMCs and designated RTHs. It ensures the rapid and reliable exchange of observational data and processed information required by the Members.

The RMTNs consist of an integrated system of links which interconnects RTHs, NMCs, and RMCs to WMCs. The RMTNs provide for the collection of observational data and the selective distribution of meteorological information to Members.

In summary, the worldwide GTS enables the NMCs to receive and distribute observational data and meteorological information to meet the requirements of Members.

Planned WWW activities for FY 1983-84 will be:

- Continue support for the aircraft to satellite data relay system which will provide important observational data from selected aircraft operating in the tropics and over data-sparse areas.
- Support the implementation of data collection platforms to enhance the collection of meteorological data from upper air and surface observing sites.
- Continue the implementation of satellite direct readout stations that are compatible with polar orbiting satellites and the WEFAX (weather facsimile) component of the geostationary satellites.

Voluntary Co-operation Program (VCP)

From the beginning of WWW, it was clear that all countries need better weather observations and improved communication systems. To help remedy deficiencies and to fully implement the WWW, the WMO established a Voluntary Assistance Program (VAP) in 1967. The name of the program was changed to Voluntary Co-operation Program (VCP) in 1979.

The WMO-VCP Program helps the developing countries to implement the WWW program by providing equipment, services, and long- and short-term study fellowships. Since the inception of the VCP, this program has provided short-term fellowships in electronics, communications, operation and maintenance of weather data collection systems, electrolytic hydrogen generators, tropical meteorology, and river flood forecasting to students from 41 countries. Long-term fellowships, through which the students receive baccalaureate or Masters degrees, have been completed by candidates from 38 countries. Highest priorities are given to those facilities needed to support the global aspects of WWW. The goal of VCP is to eliminate deficiencies in global observations and communications and to establish ground-readout stations within range of satellite Automatic Picture Transmission (APT) stations so that the countries may benefit more fully from satellite weather data.

The U. S. has contributed annually $1.5 million to VCP from 1969 through 1976, $2.0 million annually from 1977 to 1979, and $2.3 million annually from 1980 through 1982. The expected U. S. contribution for 1983 and 1984 is $2.3 million annually. Other nations have contributed approximately $2.0 million annually and plan to contribute $1.7 million annually in 1982, 1983, and 1984. Contributions have been in three categories: equipment and services (80 percent), financial contributions (about 10 percent), education and training (about 10 percent).

In preparation for the Global Weather Experiment (GWE), conducted from December 19, 1978, through November 19, 1979, the United States, under the VCP, offered assistance to some developing countries of Africa, Asia, Southwest Pacific, and Central and South America. This offer of support included 15 wind finding radars for obtaining observations of upper-level winds, and 24 Automatic Picture Transmission (APT) Systems that permit direct readout of satellite weather data used in operational forecasting and severe weather warning.

To assist developing nations improve the quality and reliability of their weather observing and communications programs, the United States, through WMO-VCP, provides technicians to nations in Central and South America to assist in installation and maintenance of observing and telecommunications equipment. VCP also provides short-term training programs for foreign nationals at the National Weather Service's (NWS) training facility in Kansas City, and long-term fellowships for more advanced training in meteorology leading to the Bachelor of Science degree at U. S. universities.

Planned VCP activities for FY 1983:

- Implement and update surface and upper-air observational programs in the tropics and the Southern Hemisphere as resources and priorities permit; maintain upper-air program in Africa.
- Continue to focus support for the implementation of VCP projects in Latin America and the Caribbean areas in support of the hurricane and tropical storm programs.

GLOBAL ATMOSPHERIC RESEARCH PROGRAM (GARP)

The goals of GARP are to improve the time, range, and accuracy of weather forecasts for periods of one day to several weeks and to obtain a better understanding of the physical basis for climate. The objectives are to conduct regional and global experiments in order to acquire, process, and analyze data; to develop physical-mathematical models; to improve the time, range, and accuracy of weather forecasts; and to obtain a better understanding of the physical basis of climate and climate fluctuations.

Base Program

The GARP and the newly initiated World Climate Research Program (WCRP) are international efforts under the cognizance of the United Nations' WMO and the ICSU. Both are conducted under the umbrella of the WWP. As stated earlier, the Department of Commerce (DOC) was designated by the President, following Senate Concurrent Resolution 67 (1968), to be the lead agency in coordinating the U. S.' participation in the WWP, including GARP. Subsequently, the National Climate Program (NCP) Act of 1978, P.L. 95-367, assigned lead responsibilities to the DOC for the NCP which includes national and international activities organized under the World Climate Research Program (WCRP). U. S. participation in the WCRP will be coordinated and implemented by the U. S. GARP office in NOAA. The climate program is discussed in Section 4 of this Plan.

Within the GARP there are two basic types of observational experiments: (1) Regional experiments which acquire data necessary to understand smaller scales of motion and their impact on the large-scale global circulation, and (2) global experiments such as the First GARP Global Experiment (FGGE), which collected a complete data set necessary for the study of the large-scale global motions and circulation which determine the changes in weather over periods longer than a few days. On January 1, 1980, a new agreement between the WMO and the ICSU was implemented which established a World Climate Research Program (WCRP) as part of the World Climate Program (WCP). This program will build directly upon FGGE through extensive use of the FGGE data set and through activities which are applicable to both FGGE and WCRP.

The economic gains to be realized from successful long-range weather prediction will be substantial. Some of the activities that will benefit are:

- Agriculture: Increased production of food and fibers; avoidance of unnecessary reseeding; fertilizing and spraying operations; improved timing of hay, grain and fruit harvests.
- Construction: More efficient scheduling of the work force; protection of materials and equipment at construction sites.
- Water Management and Conservation: Advanced warning and, where possible, avoidance of floods; and better scheduling of irrigation.
- Public Utilities (Electric and Gas): Improved energy efficiency through more accurate prediction of demands; and more efficient methods of facility repair, maintenance and replacement, and switchover.
- Transportation: More efficient routing and scheduling of air, highway, and water traffic; and decreased spoilage of perishable commodities in transit at terminals.
- Public Interest: More satisfactory scheduling of activities, including recreation and vacations; and permitting adequate planning to protect health and property.

In the climate area, improved capability to forecast climatological variables such as rainfall, temperature, sunshine, and growing seasons would be of great value in planning agricultural, energy and water resource activities, and of significant value to other economic sectors.

GARP Projects and Activities

GARP Atlantic Tropical Experiment (GATE) -- A major regional experiment of the GARP. This program was undertaken to increase our knowledge of how the dynamic processes of the tropical ocean areas affect the general circulation of the atmosphere, and thereby, to improve our ability to model and predict weather for extended periods into the future. Many GATE research projects have been successfully completed by the National Science Foundation (NSF) and they will continue to support research using GATE data in FY 1983-84.

First GARP Global Experiment (FGGE) -- Also known as the Global Weather Experiment (GWE) is leading the way to the ultimate limit of deterministic weather forecasting. It is expected to provide a worldwide test of how well existing global dynamic models of the earth's atmosphere can simulate large-scale atmospheric conditions. This is a necessary step in addressing the problem of climatic change. The formal international observing period covered 12 consecutive months, a complete seasonal cycle. This formal period was preceded by a buildup period during which the satellites of several nations and various specialized observing systems were launched and tested along with the data processing systems and models. Internationally, FGGE has now moved from the data collection phase to the research phase. Further work in organizing and archiving FGGE data to expedite the work of research scientists is still in progress.

Four basic objectives of FGGE are: (1) to improve our understanding of atmospheric dynamics and the general circulation of the atmosphere, and hence improve our ability to model those mechanisms responsible for the circulation; (2) to determine the theoretical and practical limits of atmospheric predictability; (3) to design an optimal, affordable observing system for the future; and (4) to improve models of climate change by fully and accurately simulating the annual cycle as observed over FGGE's Operational Year.

FGGE data management and archiving activities are near completion, and a comprehensive research program based on FGGE data is underway. NOAA's support of the research program is scheduled to conclude in FY 1986.

Alpine Experiment (ALPEX) -- The last scheduled field experiment for GARP is the Alpine Experiment (ALPEX), an element of the GARP mountain subprogram. The key scientific objectives of this experiment for the U. S. are to determine the large scale effects of mountains on the atmosphere by defining the characteristics of the air flow and the mass and moisture fields under varying conditions, the formation and dissipation processes of mountain winds, and the physical processes involved with the formation of cyclones on the downwind side of the mountain.

The field phase of ALPEX was completed in the Spring of 1982. The preparation of the ALPEX final data set is scheduled for completion in mid-1983 with the research phase expected to continue well into the late 1980s. The National Science Foundation (NSF) is the lead agency for the U. S. participation in ALPEX. Support for the field phase of ALPEX in FY 1982 was provided jointly by NSF and DOC/NOAA. In FY 1983-84, NSF will support research using ALPEX field data.

In addition to GARP, the National Science Foundation (NSF) supports the Seasonal Equatorial Atlantic Experiment (SEQUAL) being conducted during FY 1983-84 and the Tropic Heat Experiment (THE) in the Pacific which begins in early FY 1984. These experiments will study the dominant physical processes that redistribute heat in the tropical upper ocean and the heat exchange between the ocean and the atmosphere.

World Climate Research Program (WCRP) -- The WCRP builds directly upon FGGE. In the early phases, many activities are inseparable and equally essential for both programs. Development and testing of models that accurately simulate the annual seasonal cycle and preparation of data sets are examples. Timely collection and processing of data from selected special observing systems deployed during FGGE will be continued, e.g., tropical, Arctic and Southern Hemisphere buoys and automated aircraft reporting. Data sets for climate research that include after-the-fact compilations of specialized precipitation, ice and snow, solar and earth radiation, and oceanograhic data will be completed and made available. These will supplement other FGGE data.

Other efforts in the climate research program will include program planning, the conduct of analyses and experiments to determine the predictability of climate, the formulation and validation of models of the physical climate system and in particular ocean-atmospheric coupling, and the determination of the sensitivity of models to alternative formulations, combinations of observed data, and possible changes in current atmospheric composition, surface conditions, and radiative forcing. The program will also further technological transfer of the Special Observing Systems, developed and used in FGGE such as drifting buoys, aircraft dropwindsondes, new satellite applications, automated aircraft observations, and shipboard upper air equipment. This equipment may be used to expand operational global weather observations for the improvement of weather forecasts and for climate research studies. The NSF supports a variety of global monitoring efforts including observing the properties in the upper ocean layers to provide data for studying low frequency changes in the ocean. NSF supports a number of global monitoring and climate studies in the Antarctica.

Planned GARP activities for FY 1983-84:

- NSF will continue to support research using GATE data and ALPEX field data.
- NOAA will continue to support research using FGGE data.
- NSF will support the Seasonal Equatorial Atlantic Experiment (SEQUAL) and the Tropic Heat Experiment (THE), and research on world climate.

The funding of World Weather Programs by U. S. agencies is shown in Table 5.1.

Table 5.1 Funding of World Weather Programs
(Thousands of Dollars)

U.S. Agency	Program	FY82	FY83	FY84
DOC	GARP	5,294	5,679	3,572
NSF	GARP	8,049	6,565	6,526
DOS/AID	WWW/VCP	2,300	2,300	2,300
TOTAL		15,643	14,544	12,398

NOTE: The above funds are for "direct" support only. They do not include funds for agency programs that indirectly support the World Weather Program.

* *

OTHER INTERNATIONAL COOPERATIVE PROGRAMS

Bangladesh Disaster Alert/Agro-Climatic/Environmental Monitoring Program

After a particularly severe typhoon caused hundreds of thousands of fatalities in the mid-1970s, the U. S. Agency for International Development (AID), responding to an urgent request from the Bangladesh Government, established the Interim Cyclone Warning System in 1978. This system primarily uses data from weather satellites. NOAA and NASA provided installation of a ground station and training to operate and maintain the system. The Bangladesh Government was able, for the first time, to track typhoons in the Bay of Bengal and to issue timely warnings of storms hitting populated areas.

The project was so successful and well managed by the Bangladesh Government that AID decided to upgrade the Bangladesh handling of satellite information. NASA and NOAA were commissioned to install high-resolution picture receiving equipment and to train Bangladesh technicians to operate and maintain the equipment. This was handled under the Bangladesh Disaster Alert Project. The equipment enables Bangladesh technicians to track and forecast tropical disturbances as well as to improve river and coastal flood detection and forecasting. This project was completed in 1982.

As an outgrowth of the Disaster Alert Project, a very ambitious project was adopted by the Bangladesh Government, AID, NOAA and NASA -- the Agro-Climatic/Environmental Monitoring Project (ACEMP) for Bangladesh which will provide a highly sophisticated system of data processors, remote sensing data collection platforms (DCPs), and a research facility that will enable Bangladesh to become a main remote-sensing center in Southeast Asia. Data from LANDSAT and meteorological satellites as well as hydrological and meteorological data from DCPs will enable the Bangladesh Government to improve the management of its natural resources. This project will permit the preparation of a land use map and will aid the development of an in-country resource management information system. The project will allow estimation of acreage in agricultural production and yields of principal crops; completion of a forest resource inventory; and detection of river siltation and flooding. Meteorological and hydrological uses will include detecting and forecasting typhoons, river and coastal flooding, winter cyclones, and squall lines.

The entire U. S. funding for the Bangladesh project is provided by DOS/AID:

FY82: $614,000	FY83: $4,783,000	FY84: $29,000.

The goals of the Bangladesh project during FY 1983 and FY 1984 are:

- To complete the procurement and installation of all equipment(s).
- To continue the training of Bangladesh scientists and technicians.
- To work with the Government of Bangladesh toward a goal of having the ACEMP system operational in FY 1985.

Sahel Agrometeorological and Hydrological Program (AGRHYMET)

Subsequent to the severe drought which began in 1969 in the Sudano-Sahelian area of West Africa, which reached catastrophic proportions in 1972 and 1973, six countries (Chad, Mali, Mauritania, Niger, Senegal, and Upper Volta) established a Permanent Inter-State Committee for Drought Control in the Sahel. Gambia and Cape Verde joined the Committee in 1974. The Ministers of these countries requested assistance of international organizations specializing in the study of problems relating to drought, including certain meteorological problems. The UN responded by directing its agencies to organize the necessary assistance. For this purpose, a mission (1974) involving the United Nations Development Program (UNDP), the Food and Agriculture Organization, and the WMO, defined in detail the needs of the eight countries and prepared a "Program for the Strengthening of the Agrometeorological and Hydrological Services of the Sahelian Countries and for the Establishment of a Center for Training and Applications of Agrometeorology/Operational Hydrology."

The objectives of the Program are to contribute to the social and economic development of the Sahel by:

- Monitoring continuously and adequately the meteorological and hydrological conditions by means of modern observing networks;
- Improving the understanding of these conditions and their variations in order to forecast them;
- Applying this monitoring and understanding to human activities, and more particularly to agriculture and livestock rearing, with a view to increasing and regulating the production of the resources.

The program is developed to span 15 years and is divided into three phases of approximately five years each.

Phase I (1976-1981). Established a regional training and data processing center in Niamey, Niger. Also during this period, the program identified and began to fulfill the requirements to strengthen and modernize the national meteorological services. This was accomplished so that a fully functioning regional agrometeorological and hydrological information network could be developed during Phase II. AID contributed $6.3 million to Phase I, while other donors such as the UNDP and certain European countries provided approximately $20.3 million. Political unrest has delayed the implementation of AGRHYMET in Chad.

Phase II (1982-1987). The goal of Phase II is to make the total system operational and capable of providing information to farmers, herders, planners and other users. This will be accomplished by:

(a) Completing the agrometeorological and hydrological observing and reporting network throughout the Sahel;

(b) Implementing the data processing and analysis equipment in all the national services;

(c) Training Sahelians in equipment technology, data processing, agrometeorology, hydrology and administration.

AID's contribution to Phase II is expected to be $7.0 million while the other donors, including the member countries, are expected to contribute an additional $59.6 million.

Phase III (1986-1991). The goal of the AGRHYMET program in Phase III is to implement the capabilities attained in Phase II by generating meteorological and hydrological products and forecasts and distributing them to the users in a timely fashion. Budgetary requirements have not yet been identified for this phase.

The entire U. S. funding for the Sahel project is provided by DOS/AID:

FY82: $1,300,000 FY83: $2,030,000 FY84: $1,310,000.

El Chicon Volcano

This final item is included to illustrate recent international activity resulting from a volcanic eruption in Mexico. In 1982, the NASA satellite, Solar Mesosphere Explorer (SME) tracked the movement of the materials injected into the atmosphere by the Mexican volcano, El Chicon. In April 1982, El Chicon erupted and violently injected large amounts of material into the atmosphere at altitudes of 25 to 35 kilometers. As a consequence of this stratospheric dust layer, determinations of sea surface temperature and stratospheric ozone by observations from the NIMBUS-7 and NOAA-series satellites were found to be erroneous. The observations from NASA's SME satellite revealed that the circulation in the subtropical summer stratosphere prevented the cloud particles from moving northward of 30°N latitude. The cloud did continue to spread southward and by the Fall of 1982 began moving northward into the middle latitudes.

APPENDIX A

COMPILATION OF STATEMENTS ON WEATHER PROGRAMS SUBMITTED TO THE OFFICE OF THE FEDERAL COORDINATOR BY THE AGENCIES

DEPARTMENT OF AGRICULTURE

The nation's food and forest resources are becoming increasingly important to our domestic and international economic situation. Food has recently taken on new dimensions in foreign affairs and national security. Weather and its effect on crop yields is one of the most important factors in the Nation's agricultural production. The USDA conducts supporting research that focuses on understanding the interactions of weather and climate with plants and animals. USDA also assists the Department of Commerce in determining farmers' needs for weather information and in disseminating such information to them. The Nation's forest resource must be managed for multiple use and must be protected from adverse impacts of fire, insects, disease, and pollution.

USDA conducts research that focuses on better management of the forest resource and the role weather plays in achieving those goals pursuant to its mission. USDA takes special fire weather observations and cooperates with the National Weather Service in providing fire and land management weather information to help manage the extensive national forest land.

The mission of the supporting research is to develop and disseminate information and techniques to ensure an abundance of high-quality agricultural commodities and products while minimizing any adverse effects of agriculture on the environment. The research efforts of the Agricultural Research Service (ARS) relate directly to climatic effects and deal with developing technology and systems such as: 1) to manage precipitation and solar energy for optimum crop production; 2) to understand and manage water resources for agricultural use; 3) to understand the water-plant-atmosphere interactions; 4) to optimize the use of energy, water, and fertilizer; 5) to reduce plant and livestock losses from pests; 6) to improve techniques for irrigation and drainage; 7) to reduce plant and livestock stress from the environment; 8) to develop production, management, decision, and tactical models and systems to minimize the adverse effects of climate and weather; 9) to model the exchange between the atmosphere and gaseous compounds; 10) to develop climate-related phenological crop models for the Great Plains; and 11) to identify additional meteorological factors affecting wind erosion.

The Cooperative State Research Service (CSRS) coordinates research programs in the State agricultural experiment stations, the 1890 Land Grant institutions, and cooperating forestry schools. These institutions carry on a wide variety of research applicable to agriculture and forestry. Meteorological research in these institutions is practically all climatological. A large proportion of the project is organized into Regional Research Projects. Animals and plants suffer many stresses related to climate and are therefore the focal point of much of this research.

The Forest Service is continuing its program of meteorological supporting research, with emphasis on weather effects on forest fires and air quality. Research is directed toward supporting Federal and other land managers by providing information on fire and smoke management, for prevention of significant deterioration of air quality and related values by studying the mechanisms by which mountainous terrain affects meteorological conditions.

Investigations carried out by the Statistical Reporting Service (SRS) will determine the potential effects of weather in crop production, both domestic and foreign. One aspect of these studies is the development of models relating various weather parameters to crop yields. Research will be conducted to determine if these models can be improved by the introduction of remote sensing information such as spectral measurements made by LANDSAT satellites and soil moisture measurements from either *in situ* sensors or from sensors in aircraft or satellites. Plant growth simulation models of weather-crop-yield interactions, together with other variables affecting crop yields, have been constructed for use in short-run forecasting.

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

The National Oceanic and Atmospheric Administration (NOAA) is the principal meteorological agency of the Federal Government. By law, NOAA is responsible for reporting the weather of the United States and providing weather and flood forecasts and warnings to the general public, developing and furnishing specialized weather service for specific user groups, and recording the climate of the United States. This mission is carried out within NOAA by the National Weather Service (NWS), the National Environmental Satellite, Data and Information Service (NESDIS), and the Office of Oceanic and Atmospheric Research (OAR).

NATIONAL WEATHER SERVICE

MISSION

The National Weather Service (NWS) has the principal responsibility for the plans and operations of the basic weather services and certain specific applied services. The basic mission of NWS is to help ensure the safety and welfare of the general public with respect to the effects of weather and to further the conduct of governmental and commercial activities which are affected by weather.

In support of this mission, NWS:

- Observes and reports the weather and the river and ocean conditions of the United States and its possessions.
- Issues warnings and forecasts of weather, flood and ocean conditions.
- Develops and operates national meteorological, hydrological, and oceanic service systems.
- Performs applied meteorological research.
- Assists in developing community awareness and preparedness programs for weather related natural disasters.
- Participates in international meteorological activities, including exchange of data and forecasts.

ENABLING LEGISLATION

The basic enabling legislation and authority for weather services are listed below:

- Organic Act of 1890 created the U. S. Weather Bureau.

- Enabling Act of 1919 allowed U. S. Weather Bureau to enter into cooperative agreements for providing agriculture weather services.

- Flood Control Act of 1938 authorized the establishment, operation, and maintenance of the Hydroclimatic Network by the Weather Bureau for Flood Control.

- Federal Aviation Act of 1958 outlined duties of the Secretary of Commerce for provision of weather observations and services to aviation.

- OMB Circular A-62 established criteria for Federal coordination of meteorological services and supporting research.

SERVICES

NWS provides two broad types of services, (1) real-time operation-oriented services and (2) technical, advisory and other supporting services relating to meteorological and hydrological considerations.

The three principal real-time operational services are (1) the measurement and description of the meteorological and hydrological conditions that prevail; (2) the prediction of the future state of these conditions; and, (3) the warnings of specific conditions that threaten life, property and the conduct of business.

To support the basic warning and forecast services, the weather observations include measurements of sky conditions, temperature, wind, wind gusts, precipitation, visibility, pressure, humidity, waves, tides, currents, ocean thermal features, river stages, and solar radiation, as well as descriptions of severe weather events such as tornadoes, hurricanes, thunderstorms, blizzards, tsunamis, floods, and flash floods.

To support the applied services, additional measurements or observations are made where appropriate; e.g.,

- Marine Weather: Coastal winds, waves, tides and currents, hazards to navigation on the high seas, conditions for small craft operations, and ice and other factors affecting marine navigation.

- Aviation Weather: Cloud ceilings and visibility, altimeter settings, and such significant enroute aviation hazards as aircraft icing and turbulence.

- Agricultural Weather: Soil moisture and temperature, leaf wetness, and evaporation.

- Fire Weather: Fuel moisture and local meteorological conditions affecting wildfire control.

The forecasting services involve the prediction of the future state of these same measurements for various time periods. The content of the forecasts is influenced by the interests and the requirements of the various groups of users. Forecasts are issued on a regular, recurring basis.

The warning services are keyed to the occurrence of specific events or conditions, critical to a broad or a specific set of interests. The familiar hurricane, tornado, flood, and winter storm warnings have broad impact on public and private operations. Other warnings involve critical interests to agriculture, forest protection, boating and aircraft operations. The warning services are provided at two levels of urgency, (1) the advice that conditions are favorable for the event or condition to occur and (2) the specific warning that it will occur or is occurring.

The additional advisory and supporting services of the NWS include:

- Disaster preparedness services.
- Technical services for agriculture.
- Assistance through the Voluntary Cooperation Program of the World Meteorological Organization (WMO).
- International meteorological and hydrological advice and consultations.
- Climatological services.

PRODUCTION AND DELIVERY OF SERVICES

The operational services of the NWS are provided by a tri-level field structure (Figure A.1). There are three national guidance centers, 52 Weather Service Forecast Offices and 13 River Forecast Centers that have regional responsibilities for weather and hydrology services respectively and more than 250 facilities that provide local services. These include:

- The National Meteorological Center (NMC) at Camp Springs, MD, makes large-scale forecasts and develops associated guidance material.
- The National Hurricane Center (NHC) at Miami, FL, and two regional centers at San Francisco, CA, and at Honolulu, HI, prepares specialized forecasts, warnings, and associated guidance for hurricanes and tropical storms.
- The National Severe Storms Forecast Center (NSSFC) at Kansas City, MO, prepares specialized forecasts and guidance for tornadoes and severe thunderstorms. NSSFC's National Aviation Weather Unit provides aviation area forecasts as well as advisories to aircraft concerning potentially hazardous weather conditions on their route of flight.
- The 13 River Forecast Centers (RFC) produce specialized river and flood level forecasts and guidance material. Each RFC covers a major national watershed or portion thereof involving several states.

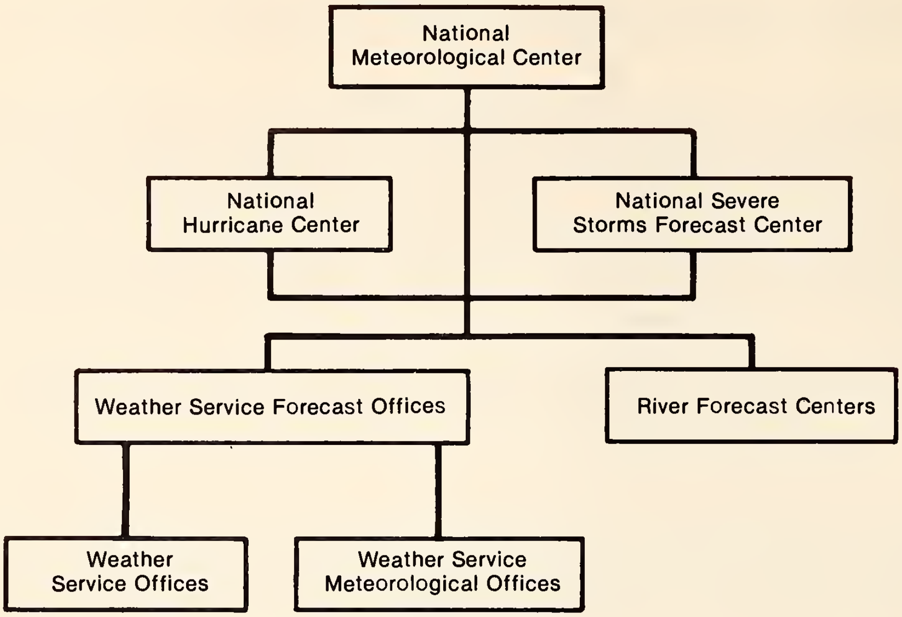

National Meteorological Center
National Hurricane Center
National Severe Storms Forecast Center
Weather Service Forecast Offices
River Forecast Centers
Weather Service Offices
Weather Service Meteorological Offices

Figure A.1. NWS Field Structure for Technical Operations

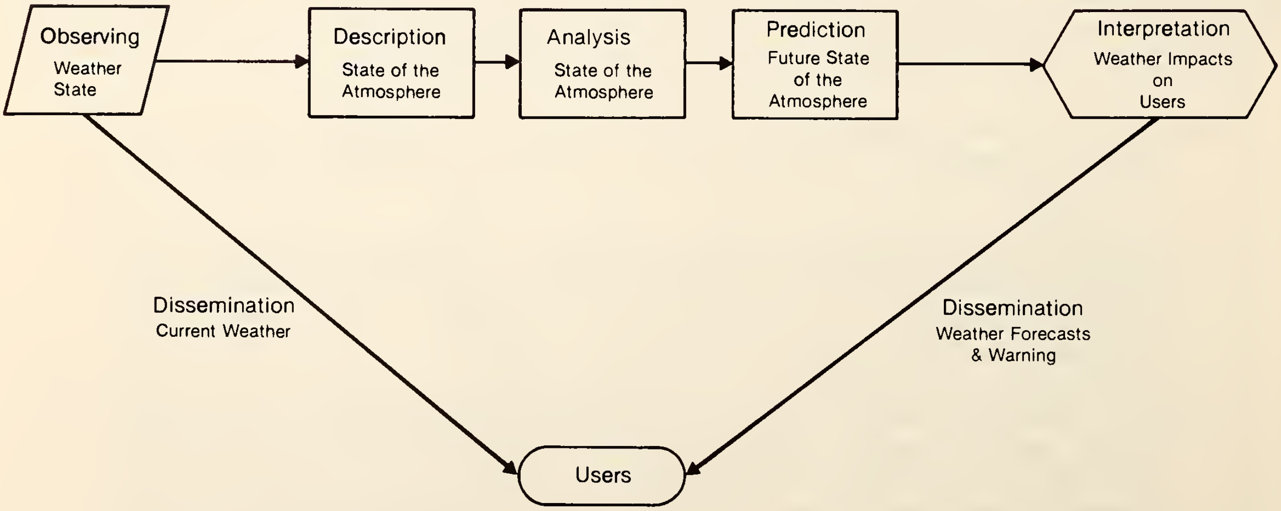


Figure A. 2. Weather Service Activities.

- The 52 Weather Service Forecast Offices (WSFO) prepare and issue medium- and small-scale forecasts, weather watches and warnings; they also acquire meteorological data. There is essentially one WSFO per State.

- The 199 local Weather Service Offices (WSO) issue small-scale forecasts and severe weather warnings; they also acquire and generate meterological and hydrological data.

- There are 39 Weather Service Meteorological Observatories (WSMO), 25 Weather Service Contract Meteorological Observatories (WSCMO), and some 600 automated observing stations that acquire data.

- There are 54 of the 251 WSOs/WSFOs with designated Hydrologic Service Area responsibility that provide public hydrologic services.

- Four of the 52 WSFOs have associated Ocean Service Units that prepare regional marine weather and oceanographic products; they coordinate services with other coastal WSFOs.

BASIC FUNCTIONS

The basic functions of the weather services consist of weather observing (data acquisition), forecast and warning preparation (analysis, prediction and interpretation), and dissemination.

The information flows from many individual sources to central facilities for analysis and the preparation of guidance, then, flows back out for increasing levels of interpretation and tailoring to specific locations and/or applications (see Figure A.2). Figure A.3 illustrates the manner in which these functions are performed in the field operations structure.

The basic weather service relies on the cooperative efforts of several agencies of the U.S. Government and the weather services of foreign countries. Figure A.4 illustrates the key interdependencies of these agencies.

Data Acquisition

The production sequence begins with the acquisition of data on atmospheric, hydrological, and oceanographic conditions for the United States and large portions of the rest of the world. Most of the data are collected by the NWS, FAA, NESDIS, the Department of Defense, weather services of other nations, and cooperative observers (the latter including land, oil platform, and shipborne cooperative observers). Some of the data also come from the Soil Conservation Service, the Forest Service, and the Geological Survey.

There are more than 1,000 principal surface observation points nationwide, with about 400 sites providing 24-hour service. Schedules at other sites are predicated on established needs; e.g., flight schedules. Most NWS observations are manually acquired although NWS is in the process of automating selected sites through its automated meteorological observing system. Elements observed include cloud cover, temperature, dew point, wind speed and direction,

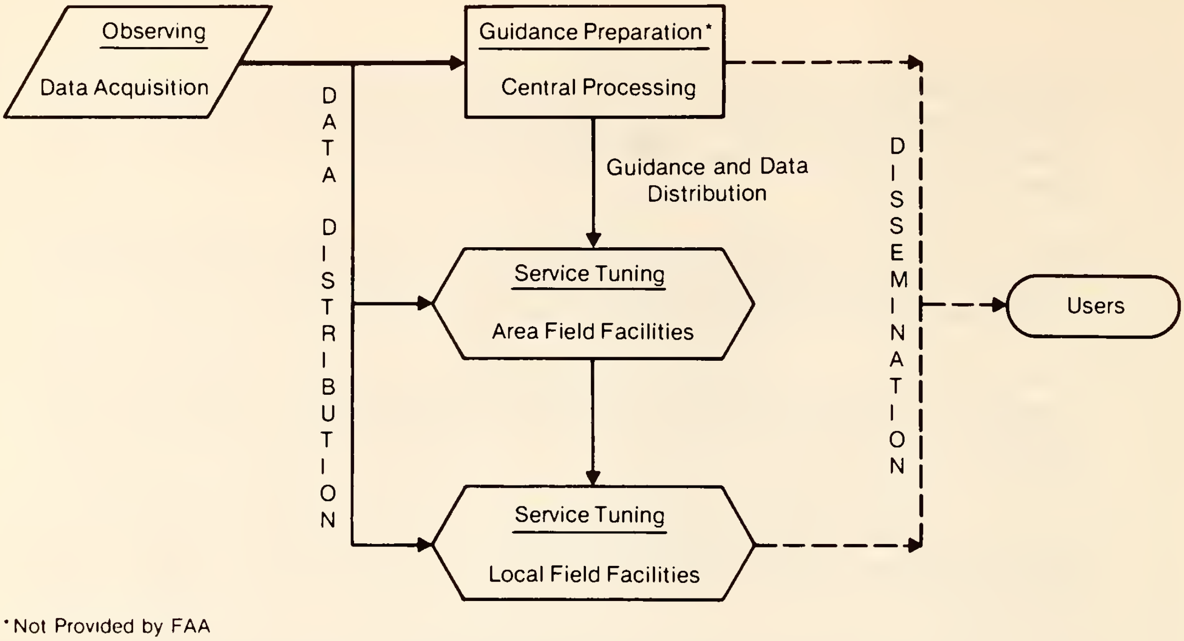


Figure A.3. Levels of Weather Service Functions.

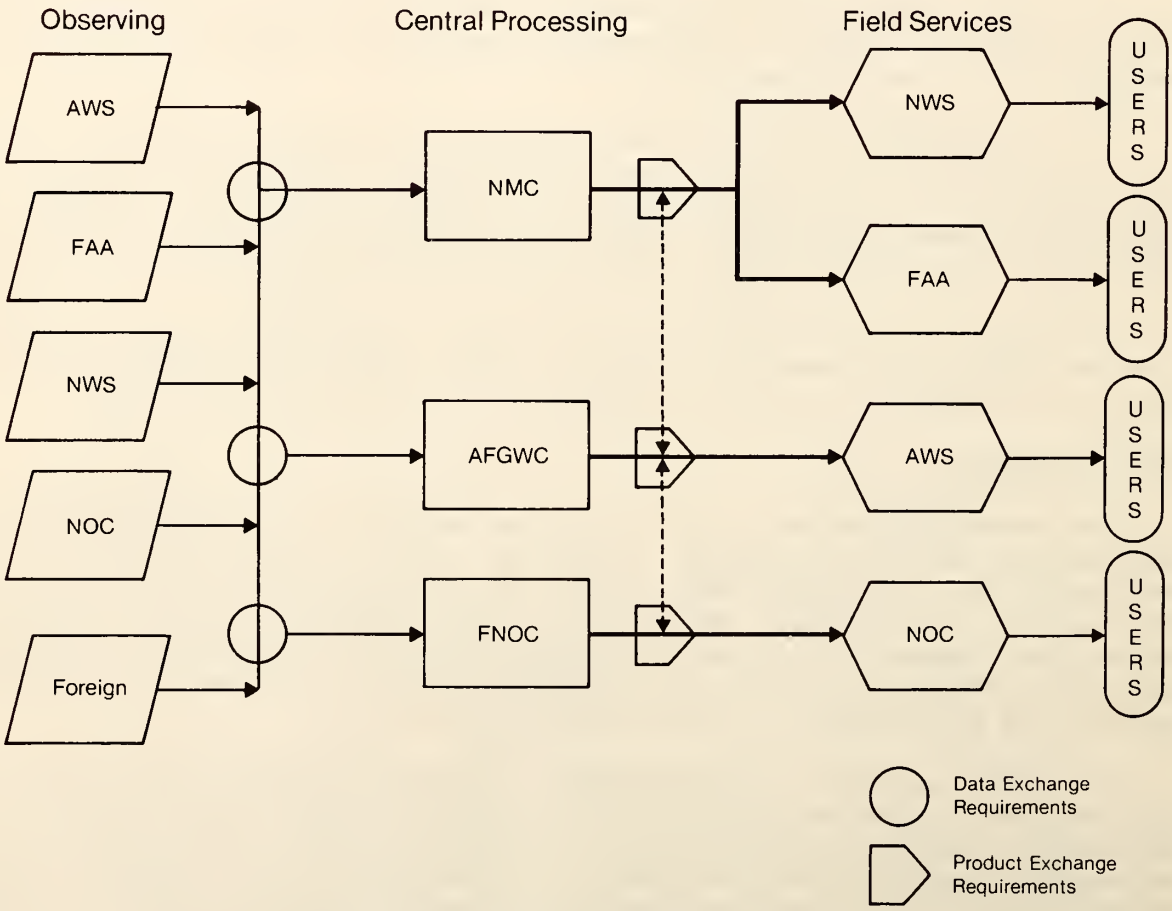


Figure A.4. Weather Service Interdependencies.

atmospheric pressure, and precipitation type and amount. These principal sites are augmented by 12,000 land-based cooperative observers, who report daily temperature and precipitation amounts.

Many of these field stations also send balloon-borne meteorological instruments aloft to measure temperature, moisture, pressure, and wind to 29 km above the surface. A few rocket soundings reach 100 km. There are 140 observation sites within the United States and its territories, the Caribbean, Mexico, and Central and South America. Most sites take two upper-air soundings per day at the standard analysis times of 0000 GMT and 1200 GMT. These soundings are augmented by weather observations from aircraft in flight and from satellites.

Specifically designed NWS weather radars monitor the location, extent, intensity, and movement of such severe or hazardous weather conditions as hurricanes, tornadoes, severe thunderstorms, and intense winter snowstorms. Weather radars are also capable of quantitative estimates of rainfall amount over specific watersheds to aid the forecasting of river floods and flash floods. About 127 weather radars are operated by NWS. These are augmented by about 90 weather radars operated by the Department of Defense. Of the NWS radars, 56 are staffed and operated continuously. NWS also makes observations from 22 FAA air traffic control radars in the mountainous regions of the west.

Polar-orbiting and geostationary environmental satellites collect large volumes of weather data in the visible, infrared, and microwave spectrums by radiometry. NESDIS operated weather satellites "see" cloud cover, profile vertical temperature and humidity fields (soundings), measure sea surface temperature, portray sea ice coverage, and provide data from which frost conditions, cloud tops, and high altitude wind fields can be derived. They also collect and relay environmental data observed by remotely located sensing equipment.

Hydrologic data are collected at about 7,000 river points nationwide. Measurements are made of river levels and precipitation amounts as input to prediction models that forecast river stages for 3,000 points. About 10% of these data are obtained automatically through NWS's Automated Hydrologic Observing System (AHOS).

NWS collects 90,000 to 95,000 marine surface weather observations monthly from cooperative weather observers aboard ships at sea worldwide. This program includes 103 countries that maintain a merchant marine. The U.S. Cooperative Ships Program is possibly the largest with over 2,000 ships in the program. There are 13 Port Meteorological Officers strategically located in U. S. ports to serve as liaison between NWS and the marine community.

Oceanographic data include "profiles" of deep ocean temperature and salinity, which are derived from bathythermographic measurements made by U.S. Department of Defense, U. S. research vessels and cooperating merchant marine ships. There are undersea measurements made at different depths. Sea-surface temperatures are observed and reported by NOAA data buoys and satellites, the U. S. Navy and American research vessels, as well as by ships-of-opportunity of many nations. Observations of tides, sea and swell are also observed and reported daily.

Forecast Preparation

The data are transmitted to all NWS organizations that have pertinent forecasting responsibilities. The organizations then process and analyze the data and use the results to prepare their respective outputs. Such organizations include the WSFOs, WSOs, and the centers that have major responsibilities for preparing atmospheric, oceanographic, and/or climatic guidance. The WSFOs are responsible for issuing flash flood watches which are alerts to the possibility of short fused floods. Flash flood warnings are issued by the WSFOs and WSOs.

Preeminent among these organizations is the National Meteorological Center (NMC), which in many respects is the key to NWS's analysis and forecast function. NMC has responsibility for developing coordinated large-scale forecasts and associated guidance material for the United States and much of the rest of the Northern Hemisphere, plus portions of the Southern Hemisphere. It produces a large number and variety of graphic products describing both current and forecast conditions throughout these areas.

Depictions of current conditions include 3-hourly and 6-hourly pressure analyses at the surface and 12-hourly analyses at about 1.5, 5.6, and 10.4 km above the surface. These products are produced by a mix of computerized numerical methods and human interventions to allow for subjective considerations. They give forecasters throughout the Nation a generalized, three-dimensional analysis of the current weather conditions. In addition, analyses of oceanographic conditions for the Gulf of Mexico, the North American coastal regions (eastern and western), and portions of the North Atlantic and Pacific Oceans are provided several times per week.

Using information on current conditions, NMC then uses objective numerical weather prediction techniques (based principally upon various models of atmospheric dynamics and Model Output Statistics (MOS)) to predict future conditions of the Nation's weather (for periods up to 10 days) and dynamic oceanographic programs to predict marine phenomena in coastal and offshore waters.

NMC transmits this information to NWS field offices throughout the Nation as guidance material for the preparation of specialized, medium-scale, and small-scale forecasts which become the final products issued to the using community. This information is distributed widely. NMC makes about 2,000 facsimile and teletypewriter transmissions daily to field forecasters. In addition, there are daily communications schedules for overseas users.

NMC's products are intended primarily to guide organizations responsible for specialized and medium-scale forecasts, and virtually all become available to the public through these forecasts. A few products, however, are disseminated without change either directly by NMC or through other NWS organizations.

Specialized forecasting covers a less-than-national area, either a variable area determined by the current and future location of hurricanes, tornado systems or other specific phenomena or by a fixed area determined by river and stream drainage. Forecasts of NSSFC and NHC fall into the first category; those of the RFCs into the second. All, however, share two common characteristics,

(1) they forecast only specific meteorological/hydrological phenomena and (2) their products represent important guidance to the WSFOs even though the products typically go to some users without change.

NSSFC prepares and issues tornado and severe thunderstorm "watches", which are then disseminated to the public in the threatened areas. A watch is a public-oriented statement which indicates that meteorological conditions are favorable for the development of severe thunderstorms or tornadoes. The watch statement may include advice as to what precautions should be taken by the public to protect itself from these hazards. As opposed to a watch, a warning of severe thunderstorms or tornadoes must be issued by the NWS field facility having county warning responsibility when the event has been sighted or indicated by radar.

NHC issues bulletins, watches, and warnings describing the current and future location, intensity, and movement of hurricanes, other tropical storms, and associated coastal tides. These bulletins are considered final products and are issued either directly or through the WSFOs to the public and other interested groups without modification.

Just as NHC and NSSFC analyze and forecast hurricanes and other severe disturbances, the RFCs develop specialized analyses and forecasts of river levels, stream flows, and flood stages to be expected in major national watersheds. They also provide runoff and snowmelt forecasts. RFC forecasts are normally disseminated to the public through the WSFOs without change. RFCs develop procedures for local flood warning systems used by over 1,000 communities to warn of impending floods.

Building primarily upon the material provided by NMC, the 52 WSFOs develop a large number of forecast products particularized in terms of area peculiarities and special user needs. These medium-scale forecasts often are issued directly to the public without further modification. A representative list of these products follows:

- State forecasts cover general weather conditions out to five days. Information includes expected amount of sunshine or cloudiness, precipitation, diurnal temperature variations and wind conditions.

- Zone forecasts are similar in content to state forecasts but are further particularized to an area generally comprising several counties or parishes.

- Recreational forecasts are similar to zone forecasts but are limited to recreational areas, beaches and pleasure boating areas, skiing areas and so on.

- Agricultural forecasts reflect a further particularization of the weather elements included in a State forecast, to allow decision-making by farmers in terms of spraying crops, irrigating, harvesting and so on.

- Aviation forecasts again represent a further particularization of weather elements, so that the information applies to airport weather conditions and inflight weather.

- Marine forecasts focus on the coastal and offshore areas, the Great Lakes and high seas. They cover general weather conditions with specific emphasis on wind and wave conditions.

- Fire weather forecasts provide the weather elements for use in fire management planning, forest and rangeland management activities, and wildfire control. These specialized forecasts are often very localized, site-specific and time-specific in nature.

Small-scale forecasting involves the modification of medium-scale products so that they describe a specific locality, such as a city and its suburbs, an airport terminal, a national forest, a farming community, a local recreational area, a point-source polluting area, and space launch and recovery areas. This process considers two different sets of variables: (1) topographic and climatological peculiarities, and (2) unique parameterization of the basic weather elements to make them useful for specialized activities. Examples of the latter would be spraying information for crop protection or estimates of fuel moisture content of the debris covering a national forest.

Many small-scale public weather forecasts are made by meteorological technicians at the WSOs. These forecasts are frequently described as local adaptive forecasts; they are not original forecasts but rather an adaptation and localization of medium scale forecasts to meet local needs.

Communications

In addition to the above discipline-oriented functions, there are substantial functions required to support the interchange of data and products within the service, the dissimination of the services to users, and the management and maintenance of operations.

The internal communications systems are in a transition stage. The use of most of the teletypewriter and facsimile circuits are being phased down, and the communication of both graphic and alphanumeric data is being concentrated on the Automation of Field Operations and Services (AFOS) system. AFOS will eventually replace the use of FAA-controlled circuits for internal NWS communications. AFOS consists of higher speed circuits (one for each NWS region) driven and interconnected by a Systems Monitoring and Coordination Center (SMCC); see Figure A.5. AFOS became the primary system for all WSFOs and about half of the WSOs within the conterminous states on August 31, 1982.

External communications (i.e., communications to the non-NOAA users of information) involve a number of types of systems which are used to deliver weather services directly to the public, to private industry, and to other specialized groups via some intermediary organization. These include:

- Government-operated teletypewriter systems to commercial TV, cable television and radio stations; e.g., NOAA's Weather Wire Service.

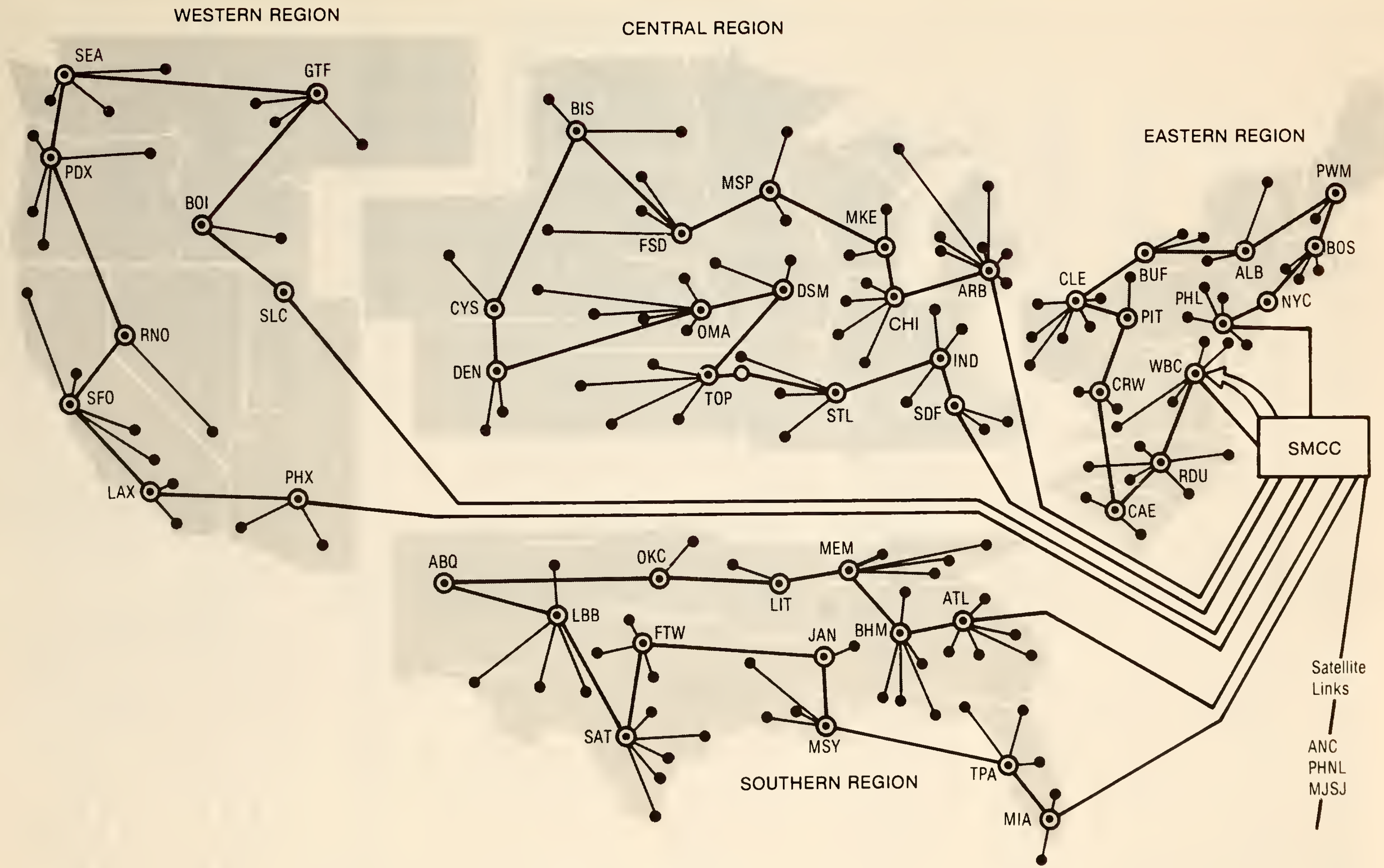


Figure A.5. AFOS Communications - Regional Loops.

- Direct radio broadcasts to the public through the NOAA Weather Radio system.

- Facsimile broadcasts to Government and non-Government users.

- Heavy-duty automatic telephone answering devices which are operated by telephone companies and which, directly, give the public weather information furnished by NWS stations.

- Direct NWS-to-the-public telephones, including automatic answering devices at NWS field offices and personalized services.

- Special interfaces to the communications systems of the agencies; e.g., FAA networks, civil defense systems, and systems operated by private companies.

- A new family of services for high volume data users to be accessed in Washington, D.C. Services include a Public Service channel, Domestic Data Service, International Data Service, NMC Product Service, and a Climate Diagnostics Data Service. The new services are scheduled to be activated from March 1983 through June 1983.

To a large extent, the success of the dissemination of services depends on the close cooperation among NWS, other government agencies and private enterprise. Service to the general public depends heavily on the news media. The NOAA Weather Wire Service, which is the chief interface to the media, is driven by the AFOS system.

With the greater emphasis on the incorporation of high technology equipment in the observation of the atmosphere and in the communication and processing of weather information, more resources in terms of facilities, maintenance and training are devoted to the support of weather service operations. More of the training is concentrated on the operations and maintenance of automated data processing systems and on developing the ability to capitalize on the capability of the systems to improve the technical quality of the weather services.

TECHNICAL ASSISTANCE TO OTHER ORGANIZATIONS

Besides developing and issuing weather reports, NWS provides a number of other services that essentially involve technical assistance, advice and consultation:

- Disaster preparedness assistance is designed to improve the response to forecasts and warnings by community officials and the public. It is carried out, within available resources, by WSOs and warning preparedness meteorologists assigned to WSFOs primarily in the eastern, midwestern and southern states. A Washington-based staff coordinates this program. The NWS effort is coordinated at all levels with the Federal Emergency Management Agency (FEMA) through a formal NOAA-FEMA Memorandum of Understanding.

- Technical hydrometeorological assistance is provided to Federal, state, and local agencies, and consulting engineers involved in water management. This involves the development of estimates of limiting rainfall amounts, probabilistic estimates of rainfall amounts and time and space distributions of rainfall associated with major storms.

- Comprehensive analyses of the meteorological factors associated with major historic storms are prepared for hurricane surge model development.

- Technical assistance to agriculture involves four Agricultural Weather Service Centers (AWSC) in Texas, Mississippi, Alabama and Indiana. These AWSCs provide technical services to farmers directly and through their respective state agricultural institutions.

- The WSFOs and WSOs provide direct technical assistance to Federal, State, and local governmental agencies, educational institutions, and the news media, as well as to the general public on a local basis.

- Technical assistance is provided to communities in developing local self-help flash flood warning systems, nationwide.

- Technical assistance to Federal and State Forest and Land Management agencies is provided in the areas of training, observation, instrumentation, and site selection and in the evaluation of weather related developmental programs.

- The Voluntary Cooperation Program provides meteorological assistance to less developed countries.

- International meteorological and hydrologic advice, consultation, and assistance are available upon request.

- NWS offices are involved in weather-related litigation activities and expert testimony.

- Climate services are offered by the Climate Analysis Center of NMC, WSFOs, WSOs, RFCs and AWSCs, in addition to that provided by the National Climatic Center of NESDIS.

APPLIED RESEARCH AND DEVELOPMENT

To ensure that the quality of NWS forecasts and services continues to improve and is in line with current state-of-the-art, applied research and development is being carried on in a number of areas within NWS.

- Numerical Prediction. Research and development is aimed at improving the day-to-day general forecast and warning services by placing the analysis and prediction system on a stronger scientific basis. Numerical prediction models that simulate atmospheric and hydrologic processes are constantly worked on and better computer techniques to solve the underlying equations are developed. Long-range prediction research is aimed at developing an improved capability to support operational planning.

- Forecasting Techniques Development. In the design, development, test and evaluation of improved objective forecasting techniques, special attention is focused on providing to field forecasters automated guidance forecasts of weather and hydrologic elements of immediate concern to the public and to users of specialized weather information, such as the aviation and agricultural communities.

- Marine Products. A program of research and development for oceanographic analysis and forecast guidance, based upon indirect and in situ observations, sea-surface temperature, winds, waves, subsurface temperatures and currents, is the principal focus of NMC's operational oceanographic effort. The effort analyzes and evaluates physical methods and numerical procedures appropriate to operational oceanographic forecasting and develops oceanic data-assimilation models capable of producing the data sets required for ocean prediction in coastal and offshore waters abutting North America. The program issues forecasts and advisories as required by NWS components.

- Short-term Climate Fluctuations. Research and development are aimed toward improving the accuracy, extent, information content and lead time of seasonal outlooks. Diagnostic studies are being conducted of short-term regional and global climate fluctuations.

- Hydrologic Models. Research efforts concentrate on the improvement of specific facets of the NWS River Forecast models using meteorological information and forecasts. Studies, augmented by research contracts, involve rainfall/runoff and snow melt processes, dam-break flood forecasting, mechanics of the rivers, data assimilation and analysis techniques, procedures to update river forecasts and extended streamflow prediction.

- Equipment Development. NWS conducts research to devise and develop new and improved techniques for measuring weather elements. Meteorological instrumentation is being developed with a primary emphasis on automating the sensing and dissemination of the data. Integration of automatic sensing equipment with AFOS will allow for computer controlled collection and processing of observational data. Test and evaluation of weather equipment are conducted at Sterling, VA. This facility, which has the capability to simulate a typical weather station, conducts tests of equipment and procedures under a wide range of environmental and operational conditions.

- Specific Products. NWS also conducts ad hoc research and development to improve the quality and timeliness of forecasts and warnings issued to the public. Research and development are conducted in the Office of Systems Development, the Hydrologic Research Laboratory, the Regional Offices, the National Hurricane

Center, the National Severe Storms Forecast Center, NMC, River Forecast Centers, and many WSFOs to improve the forecasts of hurricanes, severe local storms, general weather, general flooding, flash floods and aviation weather conditions, using both dynamic and statistical techniques.

NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE

The recently established National Environmental Satellite, Data and Information Service (NESDIS) assumes the responsibilities of the former National Earth Satellite Service (NESS) and the Environmental Data and Information Service (EDIS). Statements concerning the new line component are presented in these two principal functional groupings.

Environmental Satellite Services

Public Law 87-332 of September 30, 1961, provided the first appropriation for a national operational meteorological satellite system. This basic meteorological observing program consists of polar-orbiting and geostationary satellites. The U.S. Department of Commerce (DOC), through the National Environmental Satellite, Data and Information Service (NESDIS), is the agency responsible for a national operational environmental satellite system. DOC is charged with operating and improving the system to meet the common requirements of the Federal agencies. The objectives of this operational system are to:

- Provide global imagery of the Earth and its environment on a regular basis, day and night, including direct readout to local ground stations within radio range of the satellite.
- Obtain quantitative environmental data on a global basis, such as temperature, moisture, winds, radiation flux, and solar energetic particle flux, for use in numerical analysis and prediction programs.
- Obtain near-continuous observations of the Earth and its environment, collect data from remote observing platforms (including automatic weather stations, balloons, aircraft, ships, buoys, and river and tidal stations) and broadcast weather data to remote locations.
- Improve monitoring and prediction of the atmospheric, oceanic, and space environments by developing applications of satellite information.

The operational satellite programs are directed toward satisfying the above objectives. The system also includes command and data acquisition stations; a satellite operations control center through which the satellites are controlled and data acquired; facilities for processing and analyzing satellite data and preparing products for distribution to the users; laboratories for developing new and improving existing applications of satellite data and conducting satellite instrument experiments; and programs for determining requirements of future operational satellite systems.

Satellite Field Services Stations (SFSS) have been established to analyze, interpret and distribute processed geostationary satellite products to regional National Weather Service offices and other Federal agencies. The products are also made available to private activities at their expense. SFSSs are located in Washington, D.C.; Miami, FL; Kansas City, MO; Honolulu, HI; San Francisco, CA; Anchorage, AK; and Slidell, LA. The Anchorage SFSS distributes data from both the polar-orbiting and geostationary systems. The San Francisco SFSS also has the capability of receiving data from the polar-orbiting satellites.

POLAR ORBITING SYSTEMS

The NOAA system of environmental polar-orbiting satellites replaced the ITOS system on July 15, 1979. TIROS N, the NASA prototype, was launched by the Atlas launch vehicle on October 13, 1978; and, NOAA 6, the first NOAA-funded operational satellite of this series, was launched on June 27, 1979. On February 27, 1981, TIROS N became inoperative when its power supply failed, causing complete loss of attitude control. On June 23, 1981, NOAA 7 was successfully launched, and it became operational August 24, 1981. NOAA 6 and NOAA 7 are now the two polar-orbiting satellites.

NOAA-funded satellites retain the NOAA name and are numbered consecutively beginning with the number immediately following that last used in the ITOS series. These satellites focus on increasing the accuracy of weather forecasting by providing quantitative data required for improved numerical models. They carry advanced instruments to provide improved temperature soundings and microwave channels to facilitate sounding retrieval in cloudy areas. They also provide advanced multichannel images and carry a new data collection and platform location system. During the lifetime of the NOAA system, new instruments may be added or substituted for others. Therefore, the spacecraft are designed for a 25 percent growth capability in terms of weight, volume, power, command, and telemetry. This spacecraft will carry the first increase in payload. The first Advanced TIROS-N (ATN) satellite, NOAA E, is scheduled for launch in February 1983 and will carry a search and rescue capability in addition to its standard instruments. Later satellites will carry sensors to measure the earth's radiation budget and ozone.

These spacecraft are five-sided, box-like structures that are 3.71 m long, 1.88 m in diameter, and 1,409 kg in weight, including expendables. This third-generation system consists of two satellites in orbit; therefore, there is no instrumental redundancy on either spacecraft. NOAA 6 and NOAA 7 operate in near-polar, sun-synchronous orbits of 810 and 850 km, respectively, and provide environmental observations of the entire earth four times each day. NOAA 6 crosses the Equator in a southward direction at 0730 local time and NOAA 7 crosses the Equator in a northward direction at 1430 local time. NOAA 7 orbits at a somewhat higher altitude to avoid extended periods of readout conflict. The orbital period of the satellites is 101.58 minutes which produces 14.2 orbits per day.

The NOAA system satellites carry four primary instrument systems. The Advanced Very High Resolution Radiometer (AVHRR) provides data for real-time transmission to both Automatic Picture Transmission (APT) and High Resolution

Picture Transmission (HRPT) users and for storage on the spacecraft tape recorders for later playback. Thus, the AVHRR instrument improves satellite services in stored and direct readout radiometric data for day and night cloud cover, sea-surface temperatures, and snow mapping. The data from the AVHRR instrument on NOAA 7 are available in five operational modes. The AVHRR on NOAA 6 has only the first four modes listed below:

1. Direct readout to ground stations of the APT class worldwide, at 4-km resolution, of the visible and infrared data. Panoramic distortion is removed.

2. Direct readout to ground stations of the HRPT class worldwide, at 1.1-km resolution, of all spectral channels.

3. Global onboard recording of 4-km resolution data from all spectral channels. Global area coverage for commanded readout for processing in the NOAA central computer facility at Suitland, MD.

4. Onboard recording of data from selected portions of each orbit at 1.1-km resolution of all spectral channels with local area coverage for central processing.

5. Onboard recording of data at 1.1-km resolution of all spectral channels to enhance sea surface temperature measurements in the tropics.

The TIROS Operational Vertical Sounder (TOVS) system combines data from several complementary sounding instruments on the spacecraft. These instruments are the High Resolution Infrared Sounder (HIRS/2), the Stratospheric Sounding Unit (SSU), and the Microwave Sounding Unit (MSU). The primary instrument providing tropospheric data, HIRS/2, is sensitive to energy from the visible to the carbon dioxide region of the infrared spectrum. This instrument is designed to provide data that permits calculation of temperature profiles from the surface to 10 mb, water vapor content at three levels of the atmosphere, and total ozone content. The SSU instrument, which is sensitive to energy in the carbon dioxide portion of the infrared spectrum, provides temperature information from the stratosphere. This instrument is provided by the Meteorological Office of the United Kingdom. The third instrument, the MSU, is sensitive to energy in the oxygen region of the microwave spectrum and will be used in conjunction with the two IR instruments. The microwave data permits computations to be made in the presence of clouds.

The Data Collection System (DCS) is provided by the Centre National d'Etudes Spatiales of France. The French call this the ARGOS Data Collection and Platform Location System. The ARGOS DCS provides a means to locate and collect data from fixed and moving platforms. It provides two new services not currently present in the geostationary satellite data collection system. First, it has the capability to determine platform location, using an inverse Doppler technique. Second, it is able to acquire data from any place in the world, but more particularly in the polar regions, beyond transmission range of the geostationary satellites.

The Space Environment Monitor (SEM) measures solar proton flux, alpha particle and electron flux density, and energy spectrum and total particulate energy distribution at spacecraft altitude. The three detectors included within this instrument are the Total Energy Detector, Medium Energy Proton and Electron Detector, and High Energy Proton and Alpha Detector. This instrument augments the measurements made by NOAA's geostationary satellites. The data from the SEM are processed at Suitland, MD, and transmitted over a dedicated data link to NOAA's Space Environment Laboratory at Boulder, CO, within one hour of the spacecraft readout. The NOAA system data, along with the geostationary data, are used to monitor the state of solar activity, which has a significant effect on terrestrial communications, electrical power distribution, and high-altitude aircraft flight.

The ground system, required to receive large volumes of digital data from NOAA satellites, consists of two major subsystems -- the Data Acquisition and Control Subsystem (DACS) and the Data Processing and Services Subsystem (DPSS). The DACS includes components at the Wallops Island, VA, and Gilmore Creek, AK, Command and Data Acquisition (CDA) stations; the Satellite Operations Control Center (SOCC) at Suitland, MD,; the Western European Station at Lannion, France; and, the Satellite Field Services Station at San Francisco, CA. All the DPSS components are in the NOAA facility at Suitland.

DACS is used to command and control the spacecraft, monitor its health via housekeeping telemetry, and retrieve and transmit the spacecraft environmental data to the DPSS processing and data handling facility. The delivery of NOAA system data from the CDAs to Suitland is accomplished by using the RCA American Communications, Inc., commercial satellite communications network. This system, which includes Earth Stations at Suitland and Wallops Island, delivers the data to SOCC. These data are immediately passed on to the DPSS subsystem for initial processing.

During three (occasionally four) sequential orbits, the spacecraft is out of range of both NOAA CDA stations. To eliminate the resultant time delay in the receipt of the high-priority sounding data during the "blind" period, a Western European readout station was established at Lannion, France. This station acquires stored sounding data and transmits it to the United States via the eastern GOES satellite located at 75°W.

The DPSS ingests the raw satellite data and preprocesses and stores them along with appended auxiliary information, such as Earth location and quality control parameters. DPSS consists of several unique segments of high-speed computers, intermediate disk storage units and a mass data storage system. Thus, all the data obtained from a single NOAA system spacecraft for a 24-hour period can be stored on a single tape.

GEOSTATIONARY SATELLITE PROGRAM

The geostationary satellite program began in 1966 as an operational experiment in which the imaging capability and weather broadcast system of the NASA Applications Technology Satellites 1 and 3 were used. This program became an operational reality following the launch of NASA's Synchronous Meteorological Satellites (SMS) 1 and 2 in 1974 and 1975. These satellites were the prototypes for NOAA's Geostationary Operational Environmental Satellites (GOES).

Since GOES 1 was launched on October 16, 1975, four more GOES satellites have been put into orbit. GOES 4, launched September 9, 1980, and GOES 5, launched May 22, 1981, are the current operational geostationary satellites. GOES F is scheduled for launch in May 1983. GOES 5 is located 35,000 km over the equator at 75°W longitude and GOES 4, at 135°W. SMS 1 was deactivated on January 29, 1981, and SMS 2 was deactivated August 5, 1982. The remaining satellites are providing limited operational support for data collection, weather facsimile services and relay of data from the VISSR Atmospheric Sounder. The eastern and western satellites provide repetitive viewing of the development and movement of destructive weather systems, such as thunderstorms, hurricanes, and major mid-latitude storms over much of North and South America and adjacent oceans.

The VISSR Atmospheric Sounder (VAS) is the principal instrument on GOES and is carried on the geostationary satellites starting with GOES 4. The VAS has both imaging and sounding capability. The VAS provides near-continuous cloud viewing with resolutions of 1, 2, 4 and 8 km in the visible wave lengths and 8 km in the infrared wavelength. Full Earth disc pictures are available at 30-minute intervals throughout the day and night; partial disc pictures can be obtained at more frequent intervals to meet special requirements such as viewing development and movement of severe storms. The concept of obtaining atmospheric soundings from geostationary satellites is being tested. GOES 4 and 5 are being used in an operational demonstration program to determine the capability of the VAS. Results so far have been excellent and efforts are underway to develop a ground system to use the VAS data to improve NOAA's operational weather analysis and forecasting programs. The additional capabilities of the VAS are the multispectral imaging. The VAS has 12 infrared channels which are used to derive temperature and moisture profiles over selected areas. Sounding from a geostationary satellite affords several advantages over sounding from a polar-orbiting satellite. They are (1) constant surveillance, (2) constant viewing geometry, (3) better determination of temporal and spatial gradients, (4) easier comparison with radiosondes, and (5) synoptic large-area coverage. The VAS demonstration program has resulted in a joint NOAA/NASA project called Centralized Storm Information System. Its future development and direction of operational meso-meteorological systems will be influenced by the outcome of the VAS experiment. The GOES satellites also carry a Data Collection System which is used to collect and relay environmental data observed by a variety of remotely located platforms, such as river and tide gages, seismometers, buoys, ships, and automatic weather stations. These satellites also broadcast environmental data to remote locations using the weather facsimile (WEFAX) system and collect data for warnings of solar activity using the Space Environment Monitor.

Table A.1 shows the launch schedule for polar orbiting and geostationary satellites by the Department of Commerce.

SATELLITE COMMUNICATIONS SYSTEM (SATCOM)

The NESDIS Telecommunications System is a complex network of voice, teletype, and data grade transmissions sent via satellites, microwave, and terrestrial cable services.

A major component being supported is the Office of Satellite Operations consisting of the Satellite Operations Control Center (SOCC) and two Command and

TABLE A.1

PROJECTED SATELLITE LAUNCH SCHEDULE

POLAR-ORBITING SYSTEM

Satellite Designator	Planned Launch Date*	Satellite Designator	Planned Launch Date*
NOAA E	FY 1983	NOAA H	FY 1989
NOAA D	FY 1984	NOAA I	FY 1990
NOAA F	FY 1986	NOAA J	FY 1992
NOAA G	FY 1987		

Instruments for TIROS N Series

AVHRR - Advanced Very High Resolution Radiometer
TOVS - TIROS Operational Vertical Sounder
SEM - Space Environmental Monitor
DCPLS - Data Collection and Platform Location System
SBUV - Solar Backscatter Ultraviolet Instrument (starting with NOAA F)
SAR - Search and Rescue Instrument (starting with NOAA E)
ERBI - Earth Radiation Budget Instrument (starting with NOAA F)

GEOSTATIONARY SYSTEM

Satellite Designator	Planned Launch Date*
GOES F	FY 1983
GOES G	FY 1986
GOES H	FY 1986

Instruments for GOES Series

SEM - Space Environment Monitor
DCS - Data Collection System
VAS - VISSR Atmospheric Sounder

*Launch date depends on performance of prior spacecraft.

Data Acquisition Stations at Wallops, VA, and Gilmore Creek, AK. The Office of Satellite Operations is responsible for the operation and safety of NESS polar and geostationary satellites and for providing satellite data to the Office of Data Services in Federal Building 4, Suitland, MD.

Another major component is the Central Data Distribution Facility (CDDF) at the World Weather Building in Camp Springs, MD. The CDDF is connected in turn with the Office of Data Services, the Gilmore Creek CDA station, the seven Satellite Field Service Stations (SFSS) and with the NWS Weather Service Forecast Office at San Juan, PR. The Gilmore Creek CDA station also relays satellite data by land line and microwave circuits to the Anchorage SFSS and the NWS WSFOs at Anchorage and Fairbanks. The WSFO at Juneau, AK, receives satellite data from the Anchorage SFSS. By the end of FY 1982, SATCOM consisted of the following links:

- The Wallops Island CDA station preprocesses and calibrates the "raw" GOES data. This data is re-transmitted to the satellite which transponds the data to the Federal Office Building #4 (FOB4) facility at Suitland, MD.

- Two full-duplex circuits for delivery of stretched VAS data from FOB4 to the World Weather Building (WWB) at Camp Springs, MD (1.75 Mbps).

- Two full-duplex, C-2 conditioned voice-grade satellite and terrestrial data circuits connecting CDDF with the Anchorage SFSS and the Gilmore Creek CDA station for facsimile.

- Eighteen C-5 conditioned full-duplex circuits connect the computer facsimile outputs at the CDDF to the SFSSs. At the SFSSs, a total of about 250 "GOES-TAP" customer circuits relay the facsimile to nationwide locations. Several hundred other customers receive the facsimile over circuits that connect to the "GOES-TAP" customer circuits.

- Three C-5 conditioned full-duplex circuit from the Suitland FOB4 computer to the Wallops Island CDA station to transmit WEFAX information for GOES East, Central, and West Satellites.

- Two full-duplex, full-period voice-grade circuits conditioned for digital transmission from the Wallops Island CDA station to WWB for relay of GOES Data Collection System (DCS) information.

- Additional digitally conditioned circuits, dedicated and dial-up, for delivery of DCS information from WWB to a multitude of users.

- Two voice networks connecting all SFSSs, CDDF, FOB4 and Wallops Island CDA.

- Two digitally conditioned voice-grade circuit between FOB4 and WWB for transmitting temperature sounding data used for interactive processing.

- One digitally conditioned voice-grade circuit for transmitting FAA Service "C" data to interactive computers in WWB.

- One C-2 conditioned circuit for transmitting radar data from Patuxent Naval Air Station, Patuxent River, MD, to WWB.

- Five C-5 conditioned voice-grade, full-period, full-duplex circuits from Wallops Island CDA to WWB (two circuits), Kansas City SFSS (two circuits), and Miami SFSS (one circuit) for transmitting full disc east and west GOES IR data.

- One C-2 conditioned circuit for the transmission of facsimile data to Owings Mills, MD, for the "AM Weather" television program.

- Two C-2 conditioned circuit for the transmission of time code information from Goddard Space Flight Center to the CDDF and SOCC.

- Four C-5 conditioned circuits for the transmission of polar-orbiter facsimile from FOB4 to the CDDF and GOES data in the opposite direction.

- GMS WEFAX is transmitted to the CDDF on the duplex side of a circuit to the Honolulu SFSS.

- Meteosat WEFAX is transmitted to the CDDF on the duplex side of a GOES-TAP circuit to the Goddard Space Flight Center.

- One 50-line multipoint voice coordination and monitoring network at Suitland for control and integration of launch activities.

- One 15-line multipoint voice coordination and monitoring network at Suitland for control and integration of launch activities.

- Two 100 WPM multipoint teletypewriter circuits connecting various elements of the satellite telecommunications network.

- A direct alternate voice, data, or facsimile circuit between Washington, DC, and Moscow, USSR, for exchange of satellite information.

- Two 1.33 Mbps simplex satellite circuits for relay of NOAA system data from the two CDA stations to Suitland, MD, and to the RCA Ground Receiving Station at Offutt Air Force Base, Omaha, NE.

- Four alternate 9,600 Hz data/teletype and voice full duplex satellite and terrestrial circuits between the two CDA stations and Suitland, MD, to relay real-time NOAA system data, to transmit command and control functions to the NOAA spacecraft, and to provide alternate routing and backup for NOAA teletype and voice communications.

- Two full-duplex combination teletype and voice satellite and terrestrial circuits between the two CDA stations and Suitland, MD, for coordination of NOAA operations.

- Two simplex C-5 conditioned data facsimile circuits between the Wallops CDA station and Suitland, MD, for the relay of sectorized NOAA HRPT data.

- One simplex 48 kHz link from Wallops Island to Suitland shared with 36.2 kbps NOAA system Lannion (France) data to DOCC/DPSS and 43.7 kbps 4x4 IR GOES VAS data (4X4 mile resolution) to DPSS.

- One 9,600 bps full-duplex link between SOCC and NASCOM/GSFC for NOAA system launch support and spacecraft anomaly investigation.

- One 7,200 bps simplex link from NASCOM/GSFC to SOCC for NOAA system launch support and spacecraft anomaly data separation.

- Four SCAMMA voice circuits between NASCOM/GSFC and SOCC for NOAA and GOES launch operations and spacecraft anomalies; also, used for spacecraft backup support operations.

RESEARCH PROGRAM FOR FY 1983

The satellite-related research programs in FY 1983 will be devoted to the development and improvement of quantitative data and products that are useful for national and international climate programs, agriculture, fisheries, energy, and other weather and land applications. Techniques will be developed based on sensors on board both polar-orbiting and geosynchronous satellites to improve the algorithms to derive accurate temperature and moisture distributions that are essential for weather analysis and forecasting. Data received from the VAS instrument will be used in mesoscale meteorological studies and, in particular, to study the life cycle of severe storms over the United States. VAS data will be combined with other data received from the Prototype Regional Observing and Forecasting Service (PROFS) experiment to study the structure of short-lived weather phenomena and made available to operational forecasting centers of the National Weather Service for evaluation as an added tool for warnings and forecasts.

Satellite data received from the operational and research satellites will be used to derive improved earth-atmosphere radiation budget parameters that are essential for the climate analysis, diagnostics, and monitoring (at the Climate Analysis Center). Since the national and international climate programs consider the earth-atmosphere radiation as the most important parameter needed in various activities, the program will concentrate its efforts in this area and study the effects of clouds and their influence on the radiation budget.

In addition, NESDIS will focus on the improvement of sea surface temperature mapping for climate and other studies through the multispectral measurements and the development and testing of bio-optical techniques for NOAA-related fisheries application, using data from the Coastal Zone color scanner on the Nimbus-7 satellite. Other application research areas involve improving techniques to estimate the amounts of aerosols in the atmosphere and their effects on climate and on the accuracy of other observations; estimation of precipitation and solar insolation reaching the ground; and other geographical, geological and hydrological parameters from operational and research spacecraft, including LANDSAT. All these application-oriented research efforts will make extensive use of interactive data processing and display systems.

Data and Information Services
(Formerly Environmental Data and Information Services)

Unless otherwise noted, the authority for data and information service activities is contained in 15 USC 313, 49 USC 1463, and Department of Commerce Executive Order 25-5B. Global meteorological and climatological data and related information are received from other units of NOAA, other agencies, organizations, and individuals, both domestic and foreign, and are incorporated into the national environmental data base. The NESDIS national data base defines and documents the physical environment and its processes. It is shared with the military for their use in national defense applications. NESDIS also develops and carries out national programs required by legislation. Examples include the Principal Thrust of Generation and Dissemination of Climate Information in the National Climate Program. From the National data base, global data and information products and services are provided to over 140,000 users in commerce, industry, agriculture, science, engineering, the general public, and Federal, state and local governments. NESDIS operates three data centers and two specialized service centers.

NATIONAL CLIMATIC CENTER

The National Climatic Center (NCC) is the official custodian of U. S. Weather records and is the largest climatic data center in the world. Receiving more than 30 million observations annually from a global network of meteorological and climatological stations, the NCC edits, validates, and processes these data to publish climatological summaries used by government, industry, and private interests in decision making, resource management, and long-term planning. Environmental satellite data are also archived and furnished to users in the form of imagery of digital products. More than 58,000 subscribers receive 1,300,000 climatological bulletins each year and requesters are annually provided well over one million copies of climatological bulletins, copies of original records, or satellite photographs.

The NCC interacts with other NOAA components and many Federal agencies. These interactions serve to reduce duplication of effort, plan up-front for potential retrospective data uses, prevent data formatting pitfalls, recommend unique data sources for problem solving, suggest new approaches to the study of environmental concerns, and coordinate special applied studies.

Other interactions include the study, analyses, and publication of information on potential energy resources in cooperation with DOE and DOE contractors; application of climatological data in air and water pollution studies for EPA; AgRISTAR project and crop growth measurement with Department of Agriculture; analysis of the marine environment and publication of marine atlases with DOD; work to provide ground truth information to verify NASA satellite sensor measurements; and studies on the impact of population shift in relation to energy consumption for DOE and OMB. These examples indicate the variety and types of interagency efforts undertaken by the NCC. They should not be construed as being all-inclusive, nor should it be assumed that the Center's involvement is limited to these particular areas.

For FY 1984, the NCC expects to continue the basic programs and coordination of efforts with other agencies, and also to initiate some special programs. The planned activities include:

- The automation of Station History Files for surface data will be completed to give researchers the ability to efficiently determine the probability of homogeniety in long-term records from individual stations. This will be the culmination of a cooperative effort among NCC, NWS, and the Universities of Texas A&M and Virginia.
- Using methodologies developed in a pilot study begun in FY 1983, the NCC will launch a major project to building a long-term data base for U. S. climatological stations. These specially quality controlled data will provide a heretofore unavailable baseline, enabling scientists to determine past long-term climatic change with greater accuracy and to make better projections on future trends and the effect of carbon dioxide, volcanic ash, acid rain, etc.
- Restructuring of data base files will be accelerated. These new structures will allow faster, more efficient updating and recall. Plans also call for limited direct access of the data base by selected Federal agencies.
- Working with FEMA and other agencies, conventional satellite information will be developed and integrated into the "Natural Hazards Data Base."
- In conjunction with DOD, the Sea Ice Data Base will be maintained and expanded.
- NCC personnel will continue to take an active part in the planning for NEXRAD and the AFOS Service Records Retention System (SRRS) projects. Participation in these development stages helps assure efficient formats and usefulness of the data for end users.
- The Satellite Data Services Division (SDSD) of NCC will participate in the International Satellite Cloud Climatology Project (ISCCP), starting in FY 1983 and proceeding for a five-year period. SDSD will, as one of several Sector Processing Centers (SPCs), produce reduced resolution Level 1b AVHRR data sets to be archived and provided to the ISCCP Global Processing Center (GPC). SDSD will also act as the ISCCP International Archive and will receive climatological products produced by GPC and reduced-resolution data sets produced by the other SPCs.

NATIONAL OCEANOGRAPHIC DATA CENTER

The National Oceanographic Data Center (NODC) supports climatic services and research with three ongoing activities: (1) building and maintaining a global oceanographic data base needed for research in climate change and variability, (2) publishing the Mariners Weather Log, and (3) working with Sea

Grant Marine Advisory Service representatives to prepare coastal recreation brochures describing weather information for use by vacationers. Interagency coordination with the National Science Foundation and the U. S. Navy on data submission and processing is required.

The NODC oceanographic data base includes approximately 675,000 oceanographic stations, 950,000 digitized MBT observations, 400,000 digitized XBT observations, four million surface current observations, 200,000 buoy data records and more than seven million multidisciplinary records. Significant additions will be made to this data base during FY 1984. A major effort will go into the processing of XBT observations.

The Mariners Weather Log, a quarterly publication produced by NODC, provides marine meteorological data to weather observers, the shipping industry, Navy, Coast Guard, fishermen and private boatmen. This publication serves as the official record of weather and tropical cyclones over the world's oceans. Four issues will be published during FY 1983 and an additional four issues during FY 1984.

Coastal recreation brochures, including descriptions of beach weather conditions and water temperatures, have been produced jointly by NODC and Sea Grant Marine Advisory Service representatives for 10 U. S. ocean beach and Great Lakes areas. Three additional brochures are scheduled for FY 1983: Hawaii, Ohio Lake Erie, and Massachusetts. Three further brochures are planned for FY 1984 for the states of Florida, Texas and Washington.

NATIONAL GEOPHYSICAL DATA CENTER

The National Geophysical Data Center (NGDC) carries out a number of programs which provide data for research in Meteorology and Climatology. These include historical data bases of volcanic activity; an extensive file of ocean bottom samples and ocean drilling data; specialized data sets from the CLIMAP project which interpreted climatic conditions and geographic features from marine sediments for glacial and interglacial intervals; a variety of data on solar variability, solar flares and upper atmosphere phenomena, which are used in the study of relationships between solar variability and climate; a data inventory and coordination role for climate data derived from ice-cores; a collection of historical photographs of glaciers; a DOE-sponsored program to investigate the use of lake freeze-up/break-up data as a potential indicator of CO_2-induced climatic warming; temperature and pressure data from satellite-queried buoys placed on the central Arctic pack ice; and an extensive collection of mosaic imagery from the Defense Meteorological Satellite Program (DMSP) satellites, which is used for studies of snow and ice cover.

NGDC plans to continue and expand the services outlined above in FY84. Additional plans include the acquisition of new data from the DMSP satellites and the SEON network; derivation of climate-related indicators from lake freeze-up/break-up data; and management of data from the DOD/NOAA sea ice chart digitizing programs.

CENTER FOR ENVIRONMENTAL ASSESSMENT SERVICES

The Center for Environmental Assessment Services (CEAS) operates a series of climate assessment programs that provide user-oriented operational climatic effect reports. These programs, collectively, measure the impact of meteorological events on such diversified areas as the economy, the general public, and marine resources of the United States and of countries of concern to the U.S. They are based on historical, current and forecast meteorological data married to variations in economic and other parameters. The principal products derived from these programs are given below:

United States Publications. "Climate Impact Assessment, United States" is a monthly publication that evaluates the effects of unusual meteorological events on energy use, food production, human comfort, transportation, and other weather-sensitive economic categories. An annual summary is also published, along with special reports on the impacts of extraordinary weather events.

In FY 1984, CEAS will develop models for systematic estimations of weather impacts on GNP, transportation, lumber, and retail sales. Specifically, these models will relate weather to business activity, consumer and wholesale prices, and lumber production and shipments. Studies on the effects of weather on employee absenteeism and transportation will also be conducted.

Energy Publication. A biweekly publication on U. S. energy use, "Climate Impact Assessment, United Sates, Energy," is published every two weeks and contains weather-related cost estimates for residential consumption of heating fuels in the cold season and electricity in the warm season. The publication provides population-weighted energy use information for selected cities in the United States, the 48 conterminous States, nine census regions, and the country as a whole on a weekly, monthly, and seasonal basis. Also included during the heating season is a seasonal forecast of natural gas consumption.

In FY 1984 the Center plans to disaggregate the cost estimates by type of fuel and to derive forecasting procedures for fuel costs during the entire season.

Foreign Country Publications. The biweekly "Climate Impact Assessment, Foreign Countries" describes the likely impacts of meteorological anomalies on food production and other susceptible activites in the less developed countries of Africa, the Caribbean, Latin America, South and Southeast Asia and selected developed countries, such as the USSR, China, Canada, and Australia. The publication provides AID's Office of Foreign Disaster Assistance with an early warning system so timely measures can be taken to mitigate the effects of drought on food supplies in less developed countries. Additionally, the weather impact information is used by commercial food concerns and the USDA, CIA, Department of State, NOAA and various other government and private agencies to monitor global problem areas.

In FY 1984, the Center intends to develop and use crop models to assess impacts in much of South and Central America and to expand model coverage to include most of Africa. Models in South and Southeast Asia will be improved. Additionally, the impact of weather on economic activities other than agriculture (e.g., energy use) will be explored and included in the publication. Satellite data will be used to directly monitor vegetative growth in foreign countries.

Cables. In addition to the information published in Center periodicals, assessments for the less developed countries are transmitted at least every two weeks via cable to 100 overseas U. S. embassies and AID missions. The content is similar to that published in the foreign assessment publication. In addition, the Center ocasionally transmits special reports which address problems in individual countries.

Plans for FY 1984 call for the addition of more quantitative weather impact information in the cables.

Facsimile Products. The Center issues weekly energy consumption estimates on two facsimile circuits, DIFAX and NAFAX. Maps present city, state, and national energy use estimates for the week and the season-to-date, and forecast estimates for the entire current season.

By FY 1984 the Center intends to issue comfort index maps for the nation on the facsimile circuit. The degree of comfort or stress relative to historical weather-related levels will be shown. The index uses humidity and wind in addition to temperature to calculate human comfort or stress. Weekly, monthly, and seasonal maps will be presented.

AgRISTARS. The Agriculture and Resource Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) program utilizes climate data for agricultural purposes. This service is in support of USDA's objective of improved crop production forecasting and estimation. Cooperative efforts between NOAA and USDA provide information regarding crop yield models, their capabilities and limitation. Regression models presently provide USDA with yield estimates for the U.S., USSR, Australia, Argentina, Brazil, and Canada. The crop development, phenology, is estimated by climatological variables. This additional information is available for large areas of the U. S.

In FY 1984 additional information from satellite data will be available for user assessments of yield conditions, estimates from plant process models, and to assist USDA policymakers in estimating crop yields. Crop development models will be also tested in the AgRISTARS foreign areas. Estimates of crop development from these models will also be available to users.

Marine Resources. CEAS produces marine assessments in areas of seafood resources, transportation, tourism, and coastal and estuarine development. Assessment comprises two stages: data gathering and analysis. In data gathering, CEAS defines current and retrospective normals for environmental parameters and related economic variables, the staff then compare present events with normals to draw tentative conclusions regarding climate impact on selected economic sectors.

ENVIRONMENTAL SCIENCE INFORMATION CENTER

The Environmental Science Information Center (ESIC) is developing a National Environmental Data Referral Service (NEDRES). This service will include a computerized data base, published catalogs, and a network of cooperating organizations designed to provide information about the existence, characteristics, and availability of environmental data. Part of the NEDRES program will be a National Climate Information Clearinghouse which will provide a national inventory of climatological data.

ESIC also operates NOAA's main library system. The library is one of the major meteorological libraries in the world. It includes one of the largest collections of U.S. and foreign climatological data publications. Upon receipt of the publications, bibliographic records which identify and describe the publications are prepared and shared in a common service database with hundreds of other Federal, public, and academic libraries. The data publications are available for use in the library or can be borrowed. Additionally, online computer searches for references to published literature in all areas of climatology and meteorology are available. Finally, ESIC publishes the Daily Weather Maps, Weekly Series using material provided by the National Weather Service and Environmental Satellite Imagery, using material from the Satellite Data Services Division of NCC.

FY 1984 NEDRES activites are expected to center on the National Climate Information Clearinghouse. Through contracts with regional climate coordinating organizations, the national climate data inventory will be completed by 1984 so that only future changes and new data sets need be added. A network of cooperating organizations -- Federal, state and university -- will have begun to maintain the inventory effort and provide services to users. One or more topical or regional catalogs will be published, depending on the availability of funds.

OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH

Environmental Research Laboratories

Environmental Research Laboratories (ERL) R&D programs related to basic meteorological services are oriented toward providing the understanding and developing the techniques and new technologies that will form the basis for future improvements in the nation's weather services. The responsibility for work on this important function encompasses the mission of several ERL laboratories.

Special emphasis will be placed on the improvement of severe weather forecasting. Severe weather is any major natural hazard such as flash floods, strong winds, thunderstorms (including tornadoes and hail), and heavy snowstorms. A number of ERL labs will be cooperating to meet this goal in FY 1984.

SEVERE WEATHER

The National Severe Storms Laboratory (NSSL) in Norman, OK, focuses its research studies on severe convective storms and their associated weather hazards such as hail, high winds, heavy rain, and turbulence. The parameters of storm development and intensification are being identified through the incorporation of observations from a dual Doppler radar system, a conventional weather radar, the tallest meteorologically instrumented tower in the U. S., an automated surface network, a system for locating lightning and identifying its characteristics, and from instrumented aircraft. NSSL is preparing a three-dimensional, time-dependent numerical model of convective weather which includes the ice phase and rudimentary electrical processes as a basic resource for relating thunderstorm data to natural processes of storm initiation and development. Computer facilities will be improved, in order to utilize Doppler radar observations for initialization of convective cloud models.

With the partial support and cooperation of the Federal Aviation Administration, the National Weather Service, the United States Air Force Air Weather Service, and the National Aeronautics and Space Administration, NSSL is continuing studies to develop radar data displays for interpretation in real time. These studies are based on the demonstrated ability of pulsed Doppler radar to sense developing circulations 10-to-20 minutes prior to visual sighting of large tornadoes. Doppler radar can also sense turbulence and wind motion in optically clear air and can, thus, depict fields of motion preceding cloud development. Funds permitting, the NSSL radars will be upgraded to develop operational techniques for use with the Next Generation Radar, as well as to extend their detection of winds in clear air.

Further development of unique lightning and electrical field sensors will be translated into improved identification and warning of lightning hazards, both to aviation and to the general public.

SHORT-RANGE FORECASTING

The Wave Propagation Laboratory will operate a network of three automatic tropospheric wind profiling and total liquid water/water vapor measuring radars surrounding the prototype PROFILER (an automatic, unmanned remote sensing system for the continuous vertical profiling of winds, temperature, and humidity, located at Denver, CO) during FY 1984. The primary research effort will be to develop and to test methods of using the continuously available profile information to improve short-term local weather forecasts. The data will be made available in real-time to the Prototype Regional Observing and Forecasting Service (PROFS) Program office and to the Denver Weather Service Forecast Office (WSFO).

The PROFS program objective to improve local weather services has been refined to include early technology transfers to National Weather Service (NWS) operations. PROFS has been charged with the establishment of a capability to acquire, to interactively manipulate, and to display conventional meteorological data, satellite data, radar data, and data from local surface networks. The initial goal is to enhance NWS capability to provide severe weather and flash flood warning services. During FY 1981 and FY 1982, PROFS established communications links for acquiring the necessary data for the Exploratory Development Facility (EDF) and has developed the hardware/software capability in EDF to manipulate, process and display these data. In FY 1982, PROFS established an operational prototype system in the NWS Denver Forecast Office for real-time evaluation and ran forecasting simulations to measure improvements using PROFS technology. In FY 1983, system design specifications were completed and forwarded to the NWS. In FY 1984, emphasis will move from improved now-casting to improving short-term forecasting and warning capabilities.

MESOMETEOROLOGY AND WEATHER MODIFICATION

The Office of Weather Research and Modification (OWRM) develops techniques and technologies to improve short-term forecasts of significant weather events. Through detailed case studies and regional climatologies, OWRM scientists have developed diagnostic tools and aids to operational forecasting for severe thunderstorms, flash floods, convective storm complexes, downslope windstorms and for monitoring rainfall from satellite digital infrared data. Pioneering advances in numerical modeling of local weather have included simulations of air flow, clouds, and precipitation (rain and snow) in the Alsace region of France, in the Islands of Hawaii, and over the mountains of the western U.S. The development of a mesoscale model, which realistically simulates the pressure perturbations generated by severe convection, is also proceeding.

In FY 1984 OWRM plans to continue the transfer of knowledge about significant convective weather phenomena to NWS through courses at its training center; through visits and interactions with NWS centers, regional headquarters and field forecast offices; and through cooperative projects. A study of the adaptability of the satellite precipitation estimation technique to real-time forecast applications will be undertaken in coordination with PROFS. OWRM'S numerical weather modeling plans for FY 1984 include the continued development of a comprehensive mesoscale model. The physics of surface radiation, surface energy budgets, convection, warm and cold cloud processes leading to rain and snow, and constituent conservation equations allowing applications to acid rain problems will be tested. Improved and simplified numerical procedures will allow nesting the model in larger scales [e.g., Limited-area Fine Mesh (LFM)] so that testing with real data cases can be done. Adaption of models to special local problems such as downslope wind prediction, and streamlining them to fit into medium-sized computers for potential NWS operational applications are a next step.

The Weather Modification Program Office (WMPO) developed the Atmospheric Distributed Data System (ADDS). ADDS is an airborne data acquisition and display system. It accepts inputs from various meteorological sensors and aircraft systems, performs scaling and arithmetical calculations, and records and displays output parameters. Real time data are transmitted via satellite to the National Hurricane Center (NHC) at Miami, FL.

HURRICANE RESEARCH

The National Hurricane Research Laboratory (NHRL), an element of the Atlantic Oceanographic Meteorological Laboratories of ERL, does research directed at improved hurricane forecasts and warnings. The Laboratory's hurricane field program makes use of the highly instrumented aircraft of the Research Facilities Center (RFC) to acquire unique data sets that are analyzed to describe and understand the dynamics and energetics of the hurricane's inner intense core. NHRL also develops numerical hurricane models.

Analyses of data gathered in hurricanes DAVID (1979) and ALLEN (1980) have led to the proposal of an entirely new hypothesis for the temporal behavior of the mesoscale structure of mature hurricanes. During FY 1981 and FY 1982, modeling studies have been directed at immediate improvement of prediction models currently used by NWS and at the development of quasispectral techniques for substantially improving operational prediction models in the future.

In FY 1982, the hurricane field program focused on gathering data by omega dropwindsondes to determine the synoptic-scale environmental flow on the periphery of mature hurricanes that are predicted to be within 48 hours of landfall on the United States mainland. The observations were obtained in the middle and lower troposphere over normally data-void ocean areas at pressure levels that previous studies have shown to be important for determining storm tracks. Successful multiple releases of omega dropwindsondes were made in the periphery of hurricane DEBBY in the Atlantic and hurricane OLIVIA in the Eastern Pacific. The data were coded and transmitted in real time to be used by forecasters at NHC and were included in the operational data base at the National Meteorological Center.

NUMERICAL MODELING

The Geophysical Fluid Dynamics Laboratory at Princeton, NJ, does numerical modeling research of direct relevance to meteorological services. Three main activities are covered in this work. The first -- experimental prediction -- is the largest and has four goals:

1. To develop or improve atmospheric prediction models suitable for the time range from 5-to-30 days.

2. To identify important external forcing mechanisms and additional internal processes, which are required by models to simulate the evolution of macro-scale atmospheric disturbances over the range of several weeks to four months.

3. To search for a physically-based probabilistic approach for long-range simulation of atmospheric variation, given a suitable initial specification of the atmosphere, ocean, soil and snow-ice.

4. To study the mechanisms of particular atmospheric phenomena, such as tropospheric blocking, orographic cyclogenesis, tropical easterly waves, and sudden warming.

The second main activity is the study of hurricane dynamics, including the genesis, the development and decay of tropical depressions, and the study of small-scale features within hurricane systems.

A third area concerns mesoscale dynamics for which the goals are:

1. To produce accurate numerical simulations of mesoscale processes, in order to understand what role synoptic scale parameters play in their generation and evolution.

2. To understand the internal gravity waves (generation, interaction and breakdown) that are strongly connected with the diffusive processes in the atmosphere and ocean.

SPACE ENVIRONMENT SERVICES

The National Oceanic and Atmospheric Administration and the USAF Air Weather Service jointly operate the National Space Environment Services Center in the Space Environment Laboratory in Boulder. The Center provides predictions, summaries, indices, and alerts of disturbances occurring in the space, upper atmosphere and geomagnetic environment. The services are used by the DOD, DOT, DOC, DOI, DOE, NASA, NSF, commercial users, and the public research community to optimize the operation of technical systems that are adversely affected by disturbances in the space environment or to carry out research in the terrestrial environment. Examples of the adverse effects include loss of reduced efficiency in communications systems, radiation hazards to personnel and systems in space and on high altitude aircraft, degradation of surveillance and monitoring systems for defense, errors in navigation systems, and other perturbations on satellite orbits and operating systems.

The Center serves as the International World Warning Agency for the solar-terrestrial environment. In this role, international data are collected in real time to meet the needs of the Center; Ursigram and World Days Service are provided, and additional specific needs of other government agencies are met. In return, the Center distributes applicable data to other countries and issues a consensus set of daily forecasts for international use.

The Center operates with observations shared by a number of agencies who make their data available in real time and in return, receive the services to meet their own needs. Agencies making major contributions of data include the DOD, NASA, DOC, NSF, DOE and DOI. The Space Environment Laboratory cooperates directly with NESDIS to receive solar x-ray, particle, in situ magnetic field, and plasma data from the Space Environment Monitors on the GOES and NOAA satellites.

The data are collected, stored, displayed for analysis, and products are distributed by the Space Environment Laboratory Data Acquisition and Display System (SELDADS).

Services are distributed via teletype and digital data links (primarily operated by other agencies), via the SELDADS, by radio broadcast (WWV), by mail, and by recorded telephone messages available to commercial dial-up users.

DEPARTMENT OF DEFENSE

The Department of Defense (DOD) operates a military environmental service system to provide specialized worldwide meteorological and oceanographic prediction services in support of military forces. This service directly supports all phases of military operations, from strategic planning to tactical operations. The U.S. Navy's Naval Oceanography Command and the U.S. Air Force's Air Weather Service are the primary military performing agencies. The Army and Marine Corps each have a small generic weather support capability, but depend upon the primary weather services for most support. The military weather services contribute to the national and international weather observing capability by making conventional observations on land and at sea where there is no other conventional weather observing capability and where the observations are most needed to meet military requirements. In addition, DOD maintains special observing capabilities such as the Defense Meteorological Satellite Program and aerial weather reconnaissance to meet unique military requirements. The reconnaissance program also serves national needs for data from tropical and coastal winter storms. Observational data are sent by military communications networks to military and civil facilities in the United States and overseas.

UNITED STATES ARMY

ORGANIZATIONAL ELEMENTS AND STRUCTURE

Environmental services personnel and other personnel concerned with meteorological activities and related equipment development and funding serve in the Department of Army staff sections of the Assistant Chief of Staff for Intelligence (ACSI), the Deputy Chief of Staff for Research and Development and Acquisition (DCSRDA), Deputy Chief of Staff, Operations and Plans (DCSOPS), and the Chief of Engineers (OCE). ACSI is the focal point for Army environmental services matters, DCSRDA and OCE are responsible for environmental research, development, test, and evaluation. DCSOPS arranges for allocation of communications frequencies for radiosonde, radar, and other electronic systems used by Army environmental services units. DCSRDA provides life cycle management of meteorological equipment. DCSOPS establishes priorities for meteorological equipment and systems development and procurement. OCE has responsibility for providing specialized river and flood forecasting services and hydrologic data for the U.S. Armed Forces.

The Army has 27 authorized artillery ballistic meteorological sections located throughout the world. Their primary function is to provide accurate environmental data for correction of artillery firing. In addition, data are provided to other elements of the Army for sound ranging and Chemical/Nuclear Defense operations, fallout forecasts, and the AWS units for synoptic purposes. The 201A warrant officers annd 93F Ballistic observers are the artillery personnel used to accomplish these meteorological functions.

PROGRAM SUMMARY FOR FY 1984

The primary mission of the Army in the field of meteorology is to maximize worldwide combat and strategic effectiveness by continually improving atmospheric-related products. The Army role is defined in AR 115-10/AFR 105-3, September 15, 1980.

Army research emphasis today is being placed on determining the Airland Battlefield environment, on the impact of the atmosphere on electromagnetic (EM) transmission and systems utilizing the EM spectrum under realistic battlefield conditions (RBC); on the development of new equipment and systems for the field Army; on providing meteorological support in the research, development, and testing of material, systems and equipment; and on providing up-to-the-minute atmospheric informatioon available at the corps level. To accomplish specific objectives within these broad areas, the Army is proceeding with development of computer models describing battlefield atmospheres, is collecting field data for model construction, evaluation, and validation, and is performing laboratory experiments to determine the physical properties required to understand the battlefield atmosphere and its effect on weapons and defensive systems. Methods are being developed to use the atmosphere as a force multiplier without proliferation of meteorological equipment on the battlefield. It is expected that current efforts will make timely meteorological information routinely available to field commanders by 1990.

Concepts discussed in Airland Battle 2000 depict the battlefield of the future as an arena for sophisticated combat systems whose range, lethality, and employment capabilities will surpass anything known to contemporary arms strategists. The potential exists for realistic battlefield conditions to profoundly affect the operational effectiveness of these systems due to induced changes in atmospheric variables. The current meteorological program within the Army is comprised of three major thrusts addressing the Airland Battle concepts, and derived from this potential: (I) Battlefield Atmospheric Effects for Army Systems, (II) Atmospheric Technology Applications for Battlefield Operation, and (III) Atmospheric Data and Technology for Army RDT&E. Each of these thrusts consists of a number of interrelated major Army problems. Underpinning solutions to these problems is the laboratory's 6.1 Research Program that provides the necessary expanded basic knowledge and understanding of related atmospheric processes and behavior. The four topical areas contained in the 6.1 program are propagation, aerosol physics, atmospheric dynamicis, and remote sensing.

Propagation research is vital to undergird the design of future Army weapons systems that are dependent upon the transmission of electromagnetic energy through the atmosphere, while research in aerosol physics plays a dominant role in the determination of battlefield obscuration conditions that have a decisive effect on Army operations and modern weapon system performance. Atmospheric dynamics embraces the fields of turbulence, transport and diffusion, and the dynamic properties of clouds and fogs that directly influence high energy laser systems, smoke and chemical deployment, and frequency of occurrence of natural obscurations on the battlefield. Remote sensing of atmospheric parameters is becoming the preferred approach to determine critical atmospheric conditions on a real-time basis.

BATTLEFIELD ATMOSPHERIC EFFECTS FOR ARMY SYSTEMS

The operational effectivenss of future Army systems will be strongly influenced by the degree of understanding of complex atmospheric characteristics and how this knowledge is used in system design, development, and evaluation. A majority of Army systems slated for present and future deployment have at least one common trait - a functional dependence upon satisfactory EM propagation through the atmosphere. The performance characteristics of such classes of systems as Very Intelligent Surveillance and Target Acquisition (VISTA), Precision-Guided Munitions, Directed Energy Weapons, Direct Fire Systems, and Advanced Automated Systems, are all subject to the degradational effects of the battlefield atmosphere.

Army command and control systems will depend heavily on reliable/secure communications. VISTA addresses the capability to determine movement, characteristics, disposition, type, and intention of hostile units, and includes the employment of maneuver forces for reconnaissance in addition to ground and air based reconnaissance systems. VISTA will provide a means to correlate, integrate, and analyze surveillance/target acquisition information into usable intelligence, yet at the same time, will be the target of intense, highly sophisticated, and effective electronicc warfare operations. Countermeasure operations and precision guided munitions will be similarly influenced by changing EM propagation conditions. An understanding of the atmospheric characteristics and their influence on EM propagation specific to potential battlefields in certain key areas worldwide is necessary if the effects of site specific battlefield conditions are to be adequately accommodated. This understanding is being acquired from the process of modeling different sets of battlefield conditions, calculating potential effects, then comparing with measurements. In order to facilitate this process, atmospheric optics and electro-optical climatology data libraries are needed and are being assembled.

The Electro-Optical Systems Atmospheric Effects Library (EOSAEL) provides user-oriented models for quanntifying the obscuration effects of the dirty battlefield. The models in EOSAEL are continuously updated, and describe the transmission and scattering aspects of EM propagation for both broadband and narrowband systems under diverse conditions, including those of the smoke and dirt polluted battlefield. An extension of the AEOSAEL concept to the three-dimensional battlefield of division or smaller size, the Battlefield Atmospheric Transmission and Terrain Effects Library (BATTEL) will incorporate second order effects. These will include the influences of topography, vegetation and moisture on dust generation, and the effects of weather and background on target signatures. On a worldwide scale, the Global Electro-Optical Systems Environmental Matrix (GEOSEM) library will make available similarly appropriate models and data bases to be used primarily for senior defense managers and planners, and for wargamers.

As automated and semiautomated combat systems replace manpower intensive systems in the decade ahead, both air and ground systems will take advantage of new electronic technologies to upgrade fire control systems and self-contained weapons systems. Basic to these advances will be reliance on energy propagation through the battlefield atmosphere. Battlefield obscuration tests conducted by the Army (e.g., Smoke Week, GRAF II, and Dusty Infrared Test series) have shown that visible and infrared radiance from smoke and dust clouds can be a significant source of degradation to a system. It can therefore be anticipated that such spatially, temporally, and spectrally varying emissions will offer signficant challenges to the software engineers attempting to design algorithms to automatically detect/identify targets in a highly cluttered background.

The Army is employing advanced techniques in laser light detection and ranging (LIDAR) to remotely determine the effects of battlefield obscurants on electro-optical transmission. A LIDAR system operating simultaneously at wavelengths 1.06 um and 10.6 um has been used to measure transmittance through natural and man-made obscurants. Obscurants measured include artillery and vehicular generated dust formations, smoke from agents such as white phosphorous and hexachloroethane mixtures, and oil smokes. Data acquired with LIDAR now provides slant path and vertical profiles of fog, haze, and low level cloud extinction coefficients as a function of range. Measurements recorded in Meppen, Germany, have revealed considerable temporal and spatial variability in local fog and cloud extinction coefficient profiles. Such LIDAR data is an important addition to the weather data required to understand the European low visibility operational capability of Army electro-optical systems. A LIDAR capability being enhanced in FY 1983 will include generation of ultraviolet (UV) laser beams. UV LIDAR radiation will be used to determine the feasibility of remotely detecting deleterious biological agents and toxins. This research is directed toward improving chemical/biological (CB) warfare advance warning techniques.

Within this technology area, another research system was developed and utilized in field tests this year to provide high resolution meaasurements of EM transmission and radiance. The system is called Simultaneous Multispectral Absolute Radiometer and Transmissometer (SMART), and provides for simultaneous measurement of absolute path radiance, path transmittance, and thermal imagery. The system is unique in its simultaneous and spectral capabilities. Transmission bands include 0.55 um to 1.06 um, 3 um to 5 um and 8 um to 12 um; laser weavelengths 0.63 um, 1.06 um, and 10.6 um. Obscurants investigated included aerosols, hot gases, dust, smoke, and turbulence. Background clutter included factors such as the thermal history of the suface, scenario geometry, solar flux, and emissivity properties. Data obtained from multiple field testing programs in 1982 and others planned for FY 1983 will be combined with meteorological data to validate and improve current models, to provide an accurate data base for system designers and developers, and to provide characterization of the atmosphere during system tests.

Directed Energy Weapons (DEW) will play a significant role on the battlefields of the future. Either a laser, a high power microwave, or particle-beam weapon fits the Soviet strategic pattern and psychology, and a massive Soviet effort is speeding up the development of DEW. With the benefits of faster response, longer range, and greater accuracy, DEW's importance should not be underestimated. However, DEW's are expected to encounter challenging propagation and detectability problems on the battlefield, and the Army's basic research program should be an important contribution toward solving these problems and understanding the atmospheric effects on the DEW energy propagation.

Developmental requirements for future Army systems provide the specific objectives addressed with Thrust I listed below.

- Determine the properties of realistic battlefield atmospheres and the resultant degradation effects on the performance of Army systems.

- Determine the EM wavelength regions most favorable for Army use.

- Quantify the effects of realistic battlefield conditions (RBC) on EM energy propagation, target image and information content, and target signatures and backgrounds.

- Establish and document the means by which system designers can predict the frequency of occurrence and depth of fades for communication links from standard meteorological data bases given link frequency, length, and location.

- Determine the extent that secure communication links are compromised by ducting and scattering induced by atmospheric turbulence and hydrometeors.

- Determine the influence of atmospheric conditions on foliage penetration of proposed communications systems.

- Determine the loss in information content in transmission through RBC.

- Determine the extent of distortioin and image jitter induced by turbulence on an automatic target detector and classifier signal processors.

- Determine to what extent extinction and path radiance from dust and smoke clouds will break lock or serve as false targets for either fire-and-forget or lock-on-after-launch missiles.

- Determine the influence of backscatter from atmospheric hydrometeors and/or aerosols in disrupting automatic target classifiers, especially those utilizing doppler signatures.

- Determine the effect of the atmosphere on scene analysis.

- Determine the extent that RBS may have on remote robotic operations.

- Determine the errors introduced by refraction and optical turbulence on direct fire systems, and the extent that practical sensors and/or techniques can predict and correct for these errors.

- Develop and implement methodologies to assess the impact of atmospheric effects on DEW performance.

- Determine the extent which RBC degrades EM propagation at specific DEW wavelengths and energies.

- Assess the impact of nonlinear effects on DEW systems.

ATMOSPHERIC TECHNOLOGY APPLICATIONS FOR BATTLEFIELD OPERATIONS

Future Army systems must be maintained at an unprecedented level of performance, regardless of intervening atmospheric conditions, because the early stages of future battles, expected to be extremely quick and intense, may well determine a war's ultimate outcome. The availability of timely meteorological information on the battlefield will provide the necessary weather intelligence for command/control planning, deployment of tactical assets, and correction for the degradation of system performance by atmospheric effects.

One of the "focus for technology" points discussed in Airland Battle 2000 is a real-time target value analysis (TVA) system which will prioritize targets and identify the most effective mode of engagement. Timely meteorological information will be of critical concern in selecting and directing the correct mode. For Army systems performance to operate at peak levels, atmospheric data must be input in real time to these systems for suitable immediate corrections. Providing this data involves identifying the meteorologicaal sensors required, which depends on the parameters of interest, and where these sensors are to be placed.

A "Fire Support Element" will have three main functions; to support planning for the overall battle, to specify high payoff targets for acquisition and attack, and to coordinate the attack strategy efforts with higher, lower, and adjacent units. Capability to "see the battlefield" provided by a centralized array of air and ground based sensor systems combined with an increased capacity to communicate and process battlefield weather information will permit efficient deployment of tactical assets and optimize command/control planning. The Army is developing advanced tactical meteorological instrumentation for gathering weather intelligence in real time and providing corrections for atmospheric effects to satisfy these needs.

For example, Army personnel who will operate future weapon systems have had, up to this time, no satisfactory means to objectively measure ceiling and visibility. A hand-held ceiling-visibility sensor has been developed by the Army to provide high resolution data in real time. This visioceilometer can be used to support aircraft landings at forward area sites, in support of electro-optical precision guided munitions, or in support of other tactical systems where cloud height and visibility must be quantified. The first of three planned units has been completed and tested. Two additional units will be completed early in FY 1983 and subsequently tested in England. An eyesafe optical unit will also be completed in FY 1983 for testing. A breakthrough in the analysis of LIDAR returns made in FY 1982 has been implemented on the system which allows correct measurements of extinction even when an obscuring aerosol is increasing or decreasing by orders of magnitude with path length. This improvement allows visual range to be known along any slant path as opposed to ground based horizontal paths only. In FY 1983, the new optical units will be tested in low visibility conditions to extend instrument accuracy to include smoke, dust, rain, and other aerosol conditions.

Another of the major meteorological equipment development projects is the Meteorological Data System (MDS), AN/TMQ-31, designed to replace the aging AN/GMD-1 rawinsonde system for the measurement of upper air windspeed and wind direction, temperatue, humidity, and pressure. The AN/TMQ-31 is the newest type equipment that provides accuracies, capabilities, flexibility, and features not available in other atmospheric sounding systems. It is being designed in support of Army artillery fire, but also provides data for other Army users. The purpose of the AN/TMQ-31 is to give the artillery sections the improved capability of first round hits, even in areas obscured from observers, by providing reliable, fresh (hourly) and comprehensive meteorological data. These data are obtained through the available passive techniques of NAVAID or RDF radiosonde tracking systems.

An additional equipment development project is the AN/TMQ-30, Automatic Meteorological Station, a system consisting of a master station, seven relay units and 36 remote sensor stations. This system is designed to provide surface observations within an Army division's zone of responsibility. The remote stations transmit, via digital radio frequency link, wind speed and direction, temperature, relative humidity, precipitation, and pressure data via direct line-of-sight or relayed link to the master station. The Remotely Monitored Battlefield Sensor System (REMBASS) data transmission scheme is incorporated into the AN/TMQ-30. Transmission times are set hourly, or half hourly with a mission duration after deployment of 14 days. Stations can then be recovered, refurbished and reemplaced. Microprocessor data control and processing are utilized throughout the system, in the remote sensor stations relay units and the master station. Currently, the system is through advanced development.

A present and growing capability of many nations to develop and produce nuclear, biological, and chemical (NBC) weapons, and the apparent national attitude of several nations towards their employment, will make it imperative that forces plan from the outset to fight on an integrated conventional-nuclear-biological-chemical battlefield. Such strategy requires an understanding of battlefield atmospheric effects on the deployment, detection and defense of NBC agents, and the Army has ongoing and planned programs to investigate the spatial and temporal variability of NBC agent concentrations.

Specific objectives addressed within Thrust II are listed below.

- Identify the critical meteorological parameters that must be measured in real time to provide correction for tank fire, artillery fire, air defense artillery, HEL operations, automated systems, and VISTA systems.

- Determine the best sensors to measure these meteorological parameters.

- Determine optimal battlefield locations for these sensors to optimize meteorological information acquisition and utilization.

- Incorporate weather intelligence into the training and tactical decision making process.

- Determine how weather intelligence can be used to optimize the detection, identification, and quantification of NBC threats under RBC.

- Develop optimum techniques for the dissemination of chemical/smoke substances on the tactical battlefield.

- Quantify the extent that the atmosphere effects NBC effectiveness and countermeasures.

ATMOSPHERIC DATA AND TECHNOLOGY FOR ARMY RDT&E

Meteorological and atmospheric data are essential in tests of high priority Army weapons and materiel in order to determine modifications required for atmospheric induced errors, and what adverse effects weather can have on their performance on the battlefield in any climatic extreme. Currently the operational services essential for testing high priority Army and Department of Defense (DOD) weapons and materiel are provided through the combined efforts of both civilian and military personnel. A move toward total civilianization of the program commenced in FY 1982, will continue through FY 1983, and will be completed in FY 1984.

The primary function of operations is to provide timely and accurate meteorological data and atmospheric characterization to Army RDT&E activities. Atmospheric data are acquired at 12 permanent test sites ranging from Alaska to Panama and on a safari basis to other test areas as required. The most active of the 10 continental sites is White Sands Missile Range, where future DOD high energy laser activities will be emphasized.

Measurements and forecast services provided to the various users encompass the full range of atmospheric scales, from micrometeorological measurements and forecasts of mechanical and thermal turbulence in the surface boundary layer to macroscale measurements and forecasts of winds and thermodynamic parameters in the troposphere and stratosphere. Types of measurements include the more familiar temperature, relative humidity, pressure, solar radiation, and winds data and the more sophisticated optical turbulence, particulates, electro-optical measurements relating to seeability, remote measurements of pathwise integrated winds, and transmission measurements.

A partial list of high priority Army, DOD, and other government agency projects supported during FY 1982 includes the Space Shuttle, Assault Breaker, Multiple Launch Rocket System, Stinger, Advanced Attack Helicopter, M1 Tank, DOD National High Energy Laser Test Range, Scenario Normalization for Operations in Winter - Obscuration and the National Environment (SNOW ONE-A), and the Tropic Dirt Obscuration Test. Other support includes environmental exposure tests of system electronic components, clothing, personal equipment, and various types of construction materials.

In 1977 the decision was made to locate the National High Energy Laser Test Range (NHELTR) at the White Sands Missile Range, NM. On May 30, 1979, the Atmospheric Sciences Laboratory was designated as the lead lab for technology and support to the NHELTR. NHELTR support required the development of new methodologies and technologies to support Directed Energy Weapon (DEW) field tests. Major tri-service projects participating are:

Army:	FALW-D
Air Force:	MRAT
Navy:	SEA LITE

The system designed to provide real time data on atmospheric propagation conditions is designated as the HEL Meteorological (HELMET) support system. This system consists of four major subsystems:

- Fixed tower data acquisition system
- Remote data acquisition system
- Gas/aerosol sensing system
- Meteorological data analysis system.

The HELMET system acquires, transmits, processes, presents, and archives relevant atmospheric data. It was completed in FY 1983 and will be integrated into the High Energy Laser Systems Test Facility in FY 1983.

Test and evaluation of modern weapon systems is growing ever more complex and requires correspondingly more complex instrumentation and data acquisition systems. It is no longer possible to rely solely on in situ atmospheric measurements, nor can gross measurements of atmospheric parameters suffice if we are to use the atmosphere as a force multiplier. It is now essential that small inhomogeneities and other fine structures in the atmosphere be measured and studied and that these measurements be made in real time under realistic conditions. In order to adequately support the Army's RDT&E program, greater reliance is being placed on remote sensing and on the ability to make sophisticated measurements along lines-of-sight and at great distances. Advances made in the past few years with modernization program will be continued to keep pace with the continually and rapidly advancing fields of microelectronics, laser technology, and remote sensing techniques.

Conduct of Army operations has always been influenced by the atmosphere and its sometimes pivotal weather events, but never more extensively or criticially as today's operations using modern weapons systems under conditions of the Airland battlefield environment. As sensors, fire-control systems, weather intelligence, and communication systems become more sophisticated and important to mission objectives, the atmospheric related research investment by the Army will pay increasing dividends. The Army will be providing the products necessary to sense and determine the impact of realistic battlefield environments for the new generation of weapons systems which will be available for deployment on a worldwide basis.

UNITED STATES NAVY

OPERATIONAL PROGRAMS

During the period of this report, the Naval Oceanography Command (NAVOCEANCOM) has functioned exceptionally well and has demonstrated the capability to meet Navy and, as appropriate, DOD needs for environmental support. Emphasis is now being placed on further improvements to programs involving training, services to aviation, the Naval Environmental Display Station (NEDS) and improved computer systems and weapons system support.

To satisfy requirements for analyzing and forecasting the air/ocean environment adequately, great emphasis is being placed on cross-training former meteorology and oceanography specialists. A Geophysics Technical Readiness

Laboratory (GTRL) has been established to provide trained geophysics officers to become more aware of fleet operational needs which they support. This effort is ongoing. Also, greater attention is being given to ensure that the training of Aerographer's Mates (enlisted personnel) meet the increasingly sophisticated requirements of operational support.

The Navy's training program for both enlisted personnel and officers continues to place increasing emphasis on the total maritime environment of the world's oceans in which the fleet must operate. This interest reflects, in turn, the increasing sophistication of the Navy's ships; submarines and aircraft; their weapons and sensor systems; and command and control system; all of which are sensitive to the composite air-ocean environment.

An important program to improve services to Naval aviation is the Optimum Path Aircraft Routing System (OPARS). OPARS is a computer flight planning system developed and operated by the Fleet Numerical Oceanography Center (FLENUMOCEANCEN) to provide flight planning support to Naval aviation. It was designed specifically to support the Navy's mission of Anti-Submarine Warfare (ASW) and flights to and from ships operating at sea. OPARS provides for optimizing aircraft flight paths in the horizontal and vertical to achieve fuel efficiency and reduce enroute flight time. The system uses the Navy global environmental data base and supports all types of Navy aircraft.

NEDS units are operating and fulfilling expectations at the FLENUMOCEANCEN; the Naval Eastern, Western and Polar Oceanography Centers at Norfolk, VA, Pearl Harbor, HI, and Suitland, MD, respectively; the Naval Oceanography Command Centers at Rota, Spain, and Guam; and in the National Military Command Center in the Pentagon. Nine (9) smaller versions of the NEDS are planned for shore installations in calendar year 1983. Plans call for improved models of this series of NEDS to be installed at all NAVOCEANCOM activities with forecast responsibilities. The primary function of the NEDS is transmission, receipt, storage, manipulation and display of graphic, alphanumeric and satellite data. NEDS capabilities include the multi-colored visual display of environmental parameters that significantly improve the ability to evaluate and forecast air-ocean environmental conditions of tactical significance to the operating forces. The NEDS is compatible with the Air Force automated COMEDS system, and efforts are being made to provide for compatibility with the National Weather Service (NWS) AFOS system. This compatibility will facilitate the existing exchange of data, products, and services.

The Satellite Data Processing Center (SPC) is an operational computerized facility within the FLENUMOCEANCEN, Monterey, CA, designed to process data from the Department of Defense satellites and selected national environmental satellite systems to meet Navy requirements. Satellite information is invaluable for the analysis and forecasting of environmental conditions in data sparse ocean areas.

The primary computer system at the FLENUMOCEANCEN was upgraded during this period with the replacement of the CDC CYBER 203 with a 205 computer. This permits generation of the sophisticated air-ocean environmental products and tactical indices needed to support the increasingly complex fleet weapons and sensor systems.

The Naval Oceanographic and Meteorological Support System (NOMSS) is organized to provide global analysis and forecasting services and will be further described in the following paragraphs. The mission of the NOMSS, derived from Article 0316, Navy Regulations, 1973, is to ensure that Department of the Navy meteorological requirements and Department of Defense oceanographic requirements are met. Due to the nature of the Federal Plan, emphasis will be placed on meteorology even though in most cases it is difficult to separate meteorology from oceanography and the tactical orientation of most products. An equal simultaneous effort is being directed in oceanography.

NOMSS is primarily supported by activities and detachments assigned to the Naval Oceanography Command (NAVOCEANCOM). These activities are augmented by shipboard environmental units; geophysical (including enlisted meteorological) personnel assigned to various selected staffs, U.S. Marine Corps Aviation Weather Units, and environmental units assigned to test stations, ranges, and the Naval Support Force Antarctica. In addition, research, development, and logistics support is provided as appropriate, by the various Naval Systems Commands, Navy laboratories and the Naval Environmental Prediction Research Facility.

Shore field activities within the NAVOCEANCOM having, inter alia, meteorological responsibilities include two primary centers (the Fleet Numerical Oceanography Center (FLENUMOCEANCEN) and the Naval Oceanographic Office (NAVOCEANO)), three Naval Oceanography Centers, two Naval Oceanography Command Centers, seven Naval Oceanography Command Facilities, and 46 Naval Oceanography Command Detachments.

The FLENUMOCEANCEN Monterey, CA, is the master computer center of the NOMSS and is the hub of the Naval Environmental Data Network (NEDN). The NEDN is designed for product distribution. It is linked with the data collection networks of the U.S. Air Force and NOAA and receives world coverage of original data. From these data, basic and applied numerical (computer) products are generated by FLENUMOCEANCEN for use by NOMSS in producing specific support products and services.

The three Naval Oceanography Centers -- the Naval Western Oceanography Center (NAVWESTOCEANCEN) at Pearl Harbor, HI; the Naval Eastern Oceanography Center (NAVEASTOCEANCEN) at Norfolk, VA; and, the Naval Polar Oceanography Center (NAVPOLAROCEANCEAN) at Suitland, MD -- have been assigned broad geographical areas of responsibility for oceanographic and meteorological fleet support services and related matters. NAVWESTOCEANCEN is responsible for the Pacific and Indian Ocean areas; NAVEASTOCEANCEN, for the Atlantic and Mediterranean Sea areas; and, NAVPOLAROCEANCEAN, for the Arctic and Antarctic areas. They utilize basic and applied numerical products from the FLENUMOCEANCEN to provide environmental broadcasts and tailored support in response to specific requests from the operating forces. NAVPOLAROCEANCEN also supports and operates a Navy-NOAA Joint Ice Center which provides analyses and forecasts of sea ice conditions to the civilian community, as well as to DoD.

The two Naval Oceanography Command Centers (NAVOCEANCOMCENs) are located at Rota, Spain, and on the island of Guam. NAVOCEANCOMCEN Guam assists NAVWESTOCEANCEN in the provision of environmental services in the western Pacific and the Indian Ocean areas. NAVOCEANCOMCEN Rota assists NAVEASTOCEANCEN in the Mediterranean Sea area. Both centers utilize the basic and applied numerical products from the FLENUMOCEANCEN to provide fleet environmental broadcasts and tailored support in response to specific requests by the operating forces. NAVOCEANCOMCEN Guam has an additional responsibility for the operation of a "Joint Typhoon Warning Center" (with the Air Weather Service of the U.S. Air Force) and for the provision of tropical warnings in the western Pacific and Indian Oceans.

Six Naval Oceanography Command Facilities (NAVOCEANCOMFAC) at Jacksonville, FL; San Diego, CA; Yokosuka, Japan; Cubi Point, Philippines; Bermuda; and Keflavik, Iceland, provide limited area local and aviation environmental forecast services. Primary forecast guidance is utilized by all facilities; the overseas units augment that data from other local sources. Four of these activities command assigned detachments. The seventh, NAVOCEANCOMFAC in Bay St. Louis, MS, is responsible for manpower management, Naval Reserve matters, and training.

There are forty-five (45) Naval Oceanography Command Detachments (NAVOCEANCOMDETs) mostly located at Naval Air Stations. Each is established under an Officer in Charge or Chief Petty Officer-in-Charge who reports to a designated shore/field activity. Most of these detachments are oriented to provide direct environmental support, including aviation and oceanographic services, within their local areas. Those within the contiguous states utilize the basic and applied numerical products from both the National Meteorological Center and the FLENUMOCEANCEN to provide aviation meteorological and oceanographic services; only products from the FLENUMOCEANCEN are utilized to provide such services by detachments overseas. Three of the detachments are oriented to provide specific technical support to the NOMSS. This includes such functions as coordination of the Navy's climatological program at the National Climatic Center and liaison and coordination at U.S. Air Force bases for the interservice exchange of data and products.

SUPPORTING RESEARCH AND DEVELOPMENT

The Navy's environmental research and devlopment effort consists of a highly integrated program of basic research and exploratory, advanced engineering, and operational development work areas. A brief description of each of the major projects is provided to indicate the scope of the Navy program to support fleet operations.

Meteorological Processes Research

The objective of this area of work is to improve the understanding of the atmospheric processes with primary consideration given to improvements in the accuracy of forecasts in the lowest layers of the atmosphere over the oceans. The research includes consideration of local and regional features, the fine scale structure of interactions, and the origin, distribution and chemistry of marine aerosols.

Studies of the physics of the lower atmosphere over the ocean include investigation of the temporal three-dimensional structure of the lower atmosphere by making measurements using fixed point remote sensors (lidars, radiometers, imaging systems) and direct sensors (knollenberg aerosols spectrometers; air, dewpoint and sea-surface temperature sensors; nephelometers) on airborne platforms. The measurements are being used to develop and/or improve models of the effect of atmospheric conditions on the performance of existing and planned electro-optical (EO) and electromagnetic systems. The role of aerosols and cloud condensation nuclei in haze and fog formation is also being investigated by both experimental and theoretical methods. Temporal and spatial variability of the temperature inversion in the lower atmosphere over the ocean is being investigated to determine its relationship to marine fog formation. Plans call for the evaluation of existing features of these models to construct an improved fog forecast model for ocean areas.

Meteorological Models, Prediction, and Instrumentation

The objectives of this work area are (1) the development of numerical techniques, models, and software for analysis and prediction of all scales of atmospheric phenomena for use at the Fleet Numerical Oceanography Center, (2) the development of synoptic and/or statistical weather forecast techniques for use by the fleet meteorologists primarily on-site, (3) the investigation and/or development of cost-effective technological options for obtaining accurate and timely measurements of the natural environment needed as inputs to assess and/or predict the performance of weapons system over the marine environments, and (4) the coordination with weapons system developments at concept phases to develop environmental support requirements.

The numerical modeling work provides the base for the operational systems to be tested and implemented at FLENUMOCEANCEN. The exploratory development includes several components: (1) nested regional model development, (2) tropical cyclone dynamic predictions, (3) data assimilation system development, (4) global atmospheric model development, (5) stratospheric global model development, (6) marine boundary layer model development, and (7) modeling of unique atmospheric parameters.

The synoptic and statistical work includes: (1) tropical forecasting, (2) statistical tropical cyclone forecast aids, (3) short-range statistical forecasting, (4) marine fog forecasting, and (5), model output statistics for forecasting air-ocean parameters.

The investigations of measurement technology include examination of existing, as well as newly developed, instrumentation for suitability of operation in existing and future fleet airborne and sea-based vehicles.

Atmospheric Remote Sensing and Data Applications

The objective of this area is: (1) to investigate the practicality of measuring ocean surface and subsurface temperatures remotely with a laser radar, (2) to develop electro-optic mapping technology to meet naval requirements for tactical aerial environmental survey in coastal regions, (3) to develop a shipboard day/night laser radar system capable of routinely measuring water vapor concentration, temperature, wind and sound transmission and, (4) to develop techniques to extract a number of environmental parameters from visual, IR and microwave satellite data.

The program in this area is approximately evenly divided between sensor design and development, and processing and display applications. The sensor work is divided into laser sensors for aircraft (50%), ships (25%), and microwave sensors for satellites (25%). The processing and display component of the project is evenly divided between central site techniques for extracting atmospheric temperature, moisture, winds, and sea surface temperature from satellite radiances and imagery, and remote site direct readout methods for interpreting satellite radiances and/or imagery in real time.

Tactical Environmental Support System (TESS)

The objective of the TESS program is to develop an automated, modular environmental support system which can accommodate the broad range of requirements and capabilities of various ship types, with or without embarked environmental specialists. The TESS will provide predictions/assessments of the performance of weapons systems as influenced by natural environmental conditions, provide on-scene environmental data for use in the exercise of command and control, and display information on automated interactive graphic and alphanumeric terminals. The concept is to use state-of-the-art technology to modernize the environmental support function on ships and at supporting land stations where it is now largely a manual function with considerable interpretation required to assess the environmental impacts on the weapons system performance.

The development plan for this program has been prepared and several Navy laboratories have been tasked to start the development of component parts of the system.

Remote Ocean Surface Measuring System (ROMS)

The objective of this program is to develop and demonstrate a capability for remotely measuring ocean surface characteristics within the accuracy limits defined by Navy operational requirements. The program will provide technology options to integrate oceanographic sensors into either existing or planned satellites.

It is planned to investigate active and passive microwave sensors aboard proven satellite platforms, new antenna technology, the space shuttle, launch and retrieval techniques, and use of communication satellite systems. The satellite system will provide all-weather and day/night observations of oceanographic parameters over regions inaccessible by any other means.

Automated Environmental Prediction Systems (AEPS)

The AEPS program is continuing the development of an automated system to achieve a 1985 capability to provide essential environmental support to Navy Command and Control. This system is expected to expeditiously process and analyze meteorological/oceanographic data needed to describe air/ocean interactions in order to define environmental features affecting the Naval operating areas around the globe; to predict atmospheric and oceanographic conditions that affect Naval operations with the timeliness, accuracy, and scale necessary to meet command and control and weapons/sensor system requirements; and, to formulate, disseminate and display predicted weapons/sensor systems effectiveness indices and tactical decision aids based on predicted environmental conditions. Emphasis is on analysis and prediction improvements.

Some features of the AEPS development will be Model Output Statistics (MOS) for wind, cloud cover, ceiling and visibility; steering and wind distribution statistics in the FLENUMOCEANCEN tropical cyclone program; split-explicit tropical cyclone model; modified global prediction system for the FLENUMOCEANCEN upgraded computer; a 3-D mesoscale model; tropical cyclone strike probability; development of meteorological shipboard aids for use in tactical environmental support systems; Arctic Ice Dynamics Joint Experiment (AIDJEX), and Hibler dynamic sea ice models for the FLENUMOCEANCEN systems.

Meteorological Measuring System (MMS)

This system will correct an operational deficiency and develop an environmental measurement and display capability in support of Command and Control. MMS capability will enable: (1) measurement of on-scene environmental parameters needed to assess/predict the effect of the environment on performance of weapon systems developed in TESS and needed to support airborne ASW, AEW and ESM missions, and (2) processing, communication, storage and display of environmental data, derived products and weapons systems performance parameters generated by AEPS. MMS includes E-2 Aircraft Microwave Refractometer (AMR); P-3/S-3 Aircraft Dropsonde; shipborne Mini-Refractionsonde (Minisonde); shipborne/airborne remote sensors; and, the family of Naval Environmental Display Stations (NEDS).

Satellite Data Processing Center (SPC)

This project will fulfill a requirement to receive and process data from Defense and National satellite systems to alleviate global maritime data scarcity. During FY 1984, emphasis will be to complete development of software to receive and process data from the DMSP satellite, required by changes to sensors being flown. Additional development will be to ingest selected data from geostationary satellites in order to utilize these data as an input to the data base residing in the SPC. This will provide wind data and an additional source of sea surface temperature. The Navy will continue development of display and dissemination procedures for fleet users. Methods of using GEOSAT altimeter data will continue to be developed and will be implemented into the Satellite Processing Center.

Navy Environmental Engineering Development Program

The environmental satellite acquisition and display system development (AN/SMQ-11) is being expanded to receive high resolution civil satellite data, in addition to the Defense Meteorological Satellite Program (DMSP) data.

A siting study, installation, and calibration test of the runway weather surveillance system, Surface Condition Analyzer (SCAN), was completed at Naval Air Station, Pensacola, FL. This SCAN system is designed to measure critical water depths for predicting hydroplaning conditions on runways and it is being evaluated for Navy use.

A lightning position and tracking system (LPATS), installed at Naval Air Station Cecil Field, FL, is undergoing technical evaluation.

UNITED STATES AIR FORCE

METEOROLOGICAL SERVICES

The Air Weather Service (AWS) of the Military Airlift Command (MAC) is tasked by Air Force Regulation (AFR) 23-31 to provide or arrange for staff and operational weather services to active and reserve United State Air Force (USAF) and Army units, designated unified or specified commands, and other agencies as directed by the Chief of Staff, USAF. The primary AWS mission is to support the Air Force and Army combat operations in wartime. During peacetime, AWS prepares for this role by practicing special wartime support procedures and by providing or arranging daily weather support to its military customers. AFR 23-31 also defines certain related environmental and scientific support requirements to other DoD and U.S. Government agencies, foreign governments, or individuals. Collection, processing, and dissemination of atmospheric and space environmental data and weather modification are intrinsic to such support.

The Bureau of the Budget Circular A-62, 13 November 1963, divides meteorological services into two types, basic and specialized. Although involved in both services, AWS is more heavily oriented toward specialized services. The general functions involved in providing meteorological services include observing current weather, communicating weather data and information, preparing analyses and forecasts, issuing and disseminating warnings and forecasts, and archiving weather information for ready retrieval.

Observations

The first of these functions, observing current weather, comprises four programs: surface, upper air, radar, and meteorological satellites.

Surface observations are taken by AWS personnel in support of analysis and forecasting, but primarily for other specialized applications. Observations at both Air Force and Army locations (fixed and tactical) are manually obtained, some atmospheric elements being sensed by instruments and some directly by the observer. These observations are made available to local users and are also collected by the Automated Weather Network (AWN) for transmission to the Air Force Global Weather Central (AFGWC) and to other military and civil locations throughout the world. In FY 1983, there are 117 AWS surface observing locations or facilities in the continental United States (CONUS) and 59 overseas.

Upper air observations provide the major input for numerical analysis and forecasting. Most of this information is obtained from U.S. civil and foreign sources, as well as rawinsonde (fixed and mobile) and rocketsonde facilities, operated by AWS. Additional upper air information from data-void areas is obtained from U.S. Air Force weather reconnaissance aircraft and in-flight pilot reports from both military and civil aircraft. The Air Force performs aerial weather reconnaissance in support of U.S. military and national requirements. Thirteen WC-130 aircraft are provided by MAC's Aerospace Rescue and Recovery Service (ARRS) and seven by the Air Force Reserve (AFRES). Aerial reconnaissance weather officers and enlisted dropsonde operators are provided by AWS and the AFRES for the ARRS and AFRES aircraft respectively.

The weather radar is a principal source of information for making short-term warnings of severe weather. AWS operates 92 fixed weather radar sets (18 at overseas locations) and five tactical weather radar sets. Two of the CONUS sets are a part of the U.S. basic weather radar network; eleven are used in a backup capacity. Also, eleven of the AWS weather radars are used to support the National Hurricane Operations Plan. The tactical weather radar sets are designed and intended to support contingency operations.

The meteorological satellite system is the final observing program. The Defense Meteorological Satellite Program (DMSP) is an operational satellite system, managed by the Air Force for DOD, to support worldwide military requirements. The DMSP was designed and developed under a total system concept to provide the specialized meteorological data required by DOD. Sensors, communications, and ground processing facilities were developed to provide maximum responsiveness to the military decision-maker. The DMSP satellites are normally placed in an approximately 830-km, sun-synchronous polar orbit with a period of 101 minutes. The DMSP sensors provide visual and infrared (IR) images of the entire globe, plus temperatures and moisture soundings, auroral electron counts, and other specialized environmental data to the AFGWC. DMSP also supplies direct, real-time readout of regional cloud-cover information (visual and IR) to selected military terminals located around the world.

The present DMSP spacecraft series (Block 5D) uses an Operational Line-scan System (OLS). The OLS is a digital system designed to format and store visual and IR data. The visual sensors detect the brightness of reflected solar illumination from 0.4 to 1.1 micrometers. The IR sensors measure emitted radiation in the 8 to 13 micrometer spectral band. Beginning with the fourth Block 5D series spacecraft, the infrared spectral window was narrowed to 10.5 to 12.5 micrometers to reduce the amount of absorption by ozone and water vapor. The visual sensors were selected to optimize distinction among clouds, ground, and water. Electronic circuitry converts the sensed infrared energy directly into equivalent blackbody temperature, making temperature the displayed parameter. Visual and IR imagery are obtained at near-constant cross-track resolutions of 0.5 km (fine data) and 2.8 km (smooth data). The Block 5D satellite incorporates selective redundancy and other reliability improvements to achieve longer operational life. It uses both stellar and inertial references, together with on-board processors, to maintain stability and pointing accuracy and is significantly better than earlier DMSP satellites.

The DMSP communications and ground processing systems are designed to produce usable products within five minutes after the data stream ends. The central processing facility at the AFGWC is linked to the DMSP command readout facilities via a real-time satellite link. High-quality imagery is displayed for manual use and can be input directly into the AFGWC computers. There, it is converted into cloud parameters and collated with conventional meteorological data to produce a comprehensive three-dimensional numerical cloud analysis. The Air Force system for direct, local readout of DMSP data is a self-contained, air-transportable unit, capable of worldwide deployment in a matter of hours.

Communications

The utility of these observations of meteorological elements depends on an effective communications network. The USAF global weather communications system provides for the collection of alphanumeric and pictorial meteorological data, delivers these data to weather centrals and forecast facilities, and distributes centrally-produced products to the user. Conventional weather teletype networks; high-speed automated digital facilities; long-haul, point-to-point teletype data circuits; facsimile networks; and, radio and teletype intercept facilities constitute the Air Force Communications Command (AFCC) system.

The Automated Weather Network (AWN) is the backbone of military weather communications, using high-speed computers interconnected with 2400-4800 baud circuitry to deliver foreign and domestic weather data to designated users. Data-intercept sites in key overseas areas obtain foreign weather broadcasts for AWN delivery to the AFGWC. The USAF AWN also delivers these data to the Navy's Fleet Numerical Oceanography Center and to NOAA's National Meteorological Center. Overseas collection and dissemination teletype networks are driven by the AWN Automatic Digital Weather Switch (ADWS) computers. The CONUS ADWS at Carswell AFB, TX, drives the CONUS Meteorological Data System (COMEDS) and special teletype systems within the CONUS, an integral part of the weather collection and dissemination function. COMEDS serves as the prime communications system for the collection and dissemination of military Notice to Airmen (NOTAM) message traffic to all DOD users.

The Weather Facsimile Switching Center (WFSC) at Offutt AFB, NE, is the hub of the facsimile system, providing graphic and pictorial data to worldwide military users. WFSC drives the separate networks serving the CONUS, Europe and the Pacific, using computers to store and forward required products.

Data requirements of AWS units worldwide are met through a combination of routine delivery and an Automatic Response-to-Query (ARQ) system to satisfy their needs for mission-essential, non-routine weather data.

In addition to communications responsibilities, AFCC maintains the AWS meteorological equipment. The command also maintains the Air Force DMSP facilities and equipment. Organizational maintenance is funded through the host base while intermediate maintenance is funded by AFCC.

Analyses and Forecasts

Primary Center. Many analysis and forecast requirements for Air Force and Army customers are met by the AFGWC at Offutt AFB, NE. The AFGWC employs over 700 scientists and technicians (military and civilian) and uses five computer systems. The computer-based operation of AFGWC uses a build-and-apply concept. Worldwide weather data are relayed to AFGWC via the AWN and blended with civil and military meteorological satellite data to construct a real-time, integrated environmental data base. Scientific computer programs further digest the data to construct models of the atmosphere and forecast its future behavior. Final tailoring of the data is accomplished for application to the specific problem of the decision-maker.

The Federal Plan for Cooperative Backup Among Operational Processing Centers, designates AFGWC as backup for the NWS's AFOS system, NWS's facsimile network, NMC's computational center for aviation wind forecasts, and NWS's National Severe Storms Forecast Center (NSSFC).

Specialized Center. The USAF Environmental Technical Applications Center (USAFETAC), Scott AFB, IL, provides environmental data to support the U.S. Air

Force, U.S. Army, and other Government agency requirements for assessments of natural environmental effects on military plans, weapon systems, facilities, and intelligence activities. USAFETAC collects environmental data from its parent organization (AFGWC), then sorts, checks, and stores these data. USAFETAC operates a facility collocated with the National Climatic Center in Asheville, NC, for the exchange of climatic data with civil agencies. USAFETAC typically stores worldwide weather observations, surface weather analyses, upper atmosphere analyses, and unique three-dimensional cloud analyses extracted from meteorological satellite imagery. From these stored data, USAFETAC provides standard climatological products such as atmospheric profiles, soil moisture assessments, and probabilties of cloud-free line-of-sight.

Area and Guidance Centers and Weather Service Offices. AWS contributes to the unique global needs of military aviation and makes its information available to civil aviation. AWS provides pre-mission briefings and air/ground radio services, tailoring observations, forecasts, and warnings for unique military aircraft requirements.

An aspect of special emphasis in military weather support is the need to provide adequate decision-assistance to commanders and resource managers. To fulfill this requirement, designated AWS personnel serve as part of the working staff of supported Air Force and Army units. In this capacity, AWS identifies all weather-sensitive areas of the supported operation, monitors the weather service provided in these areas, and provides expert advice when weather threatens to restrict training or combat operations. This AWS effort helps ensure that Air Force and Army units are able to fulfill their missions in spite of adverse weather, and it results in efficient use of weather resources by gearing them to mission-essential support needs.

The Air Force and Army require worldwide meteorological services to support specific operational and planning activities. Military users require meteorological information directed to the needs of weapon systems being developed or used; command and control systems; Army firing units; research, development and evaluation; training and deployment of military forces; and contingency operations.

To provide these services, AWS maintains analysis and forecasting facilities in the United States and abroad, including the AFGWC in the U.S. and theater forecast units in Europe and Korea. Specialized centers, such as USAFETAC and the Joint Typhoon Warning Center on Guam, also fulfill unique military meteorological requirements. Similarly, AWS observing facilities obtain data in direct support of special military operations.

Aerial weather reconnaissance plays a vital role in specific military operations. Essential weather observations from tropical cyclones, along tactical deployment routes, from in-flight refueling areas and from missile and satellite recovery areas, are obtained by weather reconnaissance aircraft. In addition, these aircraft provide supplemental vertical soundings over data-sparse ocean areas.

AWS, through AFGWC, directly supports DOD Special Strategic Programs, the National Command Authority, the National Military Command System, and the National Security Agency. Tailored environmental support products are disseminated to these customers worldwide.

In support of tactical military operations, AWS support is designed around two basic components: the Centralized Units (CPUs) and Weather Teams (WETMs). The CPUs consist of AFGWC, USAFETAC, theater Forecast Units (FUs) and Tactical Forecast Units (TFUs) and area Weather Support Units (WSUs). AFGWC and USAFETAC provide direct, mission-tailored support through designated communications circuitry (including the AWN) to FUs, TFUs and WETMs. Theater Forecast Units are specifically named units (e.g., European Forecast Unit - EFU, Korean Forecast Unit - KFU) designated to provide forecast services and products from a fixed location for a specific geographical area, tactical operation, or exercise. A TFU provides the same services as theater FUs; however, it is activated and deployed to support a specific contingency, activity, or exercise which is not or cannot be supported by theater FUs. These units provide the required support through relay of AFGWC products, tailoring of operational support products, and local generation of mission support products. WETMs are the basic units supporting customers in a tactical theater. They provide surface and upper air observations (often using tactical weather equipment such as the TMQ-22 and the Belt Weather Kit), briefings, and forecasting support. The Tactical Weather System (TWS), tactical weather radar (AN/TPS-68), and tactical meteorological satellite direct readout terminals (Mark IV) provide the means to acquire vital meteorological data within a theater. A broadcast system to link elements of the theater weather support force with the Defense Communications System is planned. Main components of the broadcast system will be send and receive teletypes (reliable, secure, tactically deployable), receive facsimile sets, and broadcast stations.

AWS integrates Army weather support into its overall support concept. AWS personnel are trained and oriented on applicable Army organizations, concepts of operations, and weather sensitivities required to satisfy Army environmental requirements. AWS support units are aligned and integrated with the Army intelligence organization. Support products are in a form which is directly usable and understandable by Army personnel, and are integrated into Army communications systems. Mobile and fixed meteorological equipment for use in Army support is programmed by AWS. In a tactical environment, direct forecast support is normally provided down to corps, divisions, separate brigades, regiments, and groups. Observer support is normally provided at these levels and at brigade levels within the division.

AWS provides meteorological support to the nation's space and missile programs. This includes a wide range of weather observing services at the Air Force Eastern Space and Missile Center and the Kennedy Space Center. AWS also provides the forecasting service for NASA's unmanned launches at the Kennedy Center.

AWS provides specialized meteorological services for the Air Force Western Space and Missile Center at Vandenberg AFB, CA, and the Pacific Missile Range which includes Pt. Mugu and San Nicholas Island, CA, and Barking Sands, HI. AWS also supports the White Sands Missile Range, NM, the Kwajalein Missile Range, and other DOD research and test facilities.

USAF and Army operational requirements for environmental support are the basis for all AWS actions to improve existing or acquire new capabilities. AWS assesses these requirements and attempts to satisfy them through either hardware acquisitions or technique development.

Plans

AWS plans to modernize its base-level weather support systems. This includes an Automated Weather Distribution System (AWDS) and an Advanced Weather Radar (AWR). Both AWDS and AWR have R&D funds budgeted during the period of this plan.

AWDS will perform two major functions, automated surface observing and data-handling. It will incorporate the latest state-of-the-art data processing, communications, and display technologies. The observing function will take, display, and transmit (long-line and locally) surface weather observations. The data-handling function will maximize forecaster capability. A modular design will permit AWDS to be operated in a fixed or mobile environment and minimize staffing requirements. Initial installation is planned for late 1987 with completion of overseas and tactical installations by 1990. AWDS will be able to receive information from the NWS systems and the Naval Oceanography Command.

AWR is being procured under the auspices of the Next Generation Weather Radar (NEXRAD) Joint System Program Office. NEXRAD will be an automated, digitized, S-band Doppler system that will be jointly developed, procured, operated, and maintained by the DOD, NOAA, and FAA within the CONUS and by the USAF overseas. The system will be designed to incorporate the latest technological advances in Doppler radar, data processing, communications, and display. The CONUS NEXRAD network will satisfy weather radar requirements in support of the general public, the military, and the entire spectrum of the aviation community. Installation of the NEXRAD is planned between 1987 and 1990.

FY 1981 funds were approved to modify the current AWS AN/FPS-77 weather radars (to replace transmitter and receiver circuitry components). Modification kits were delivered to field units in 1982. Installation of the kits is scheduled to continue through October 1983. This action will ensure the continued logistics and maintenance support of the AN/FPS-77 radar until AWR becomes operational. The AN/TPS-68 tactical weather radar was fielded during 1982.

In the field of weather reconnaissance, AWS, through the Air Force Logistics Command (AFLC), has ongoing programs to upgrade current capabilities by improving system reliability and maintainability. An improved controller and universal counter replaced older unsuppportable components of the AN/AMQ-29 dropsonde recording system during FY 1982. An improved weather reconnaissance and dropwindsonde capability is being evaluated. The feasibility of using off-the-shelf equipment and in-house development of these capabilities is being considered in an attempt to minimize costs.

The Air Force is modifying airfield meteorological equipment to replace obsolete vacuum tube components with solid-state electronics. These actions will materially reduce logistics and maintenance costs and increase equipment in-commission time. A $1 million contract was awarded in July 1978 for 344 modification kits to convert inventory transmissometers (AN/GMQ-10) to solid state circuitry. Delivery to AWS field units is expected to be completed in FY 1981.

In the area of atmospheric pressure measurement, the USAF has converted from wide-bore, mercurial barometers to dead-weight piston gauges used as regional primary pressure standards. Funds were approved for FY 1981 to procure a digital barometer and altimeter setting indicator (DBASI). Tele-Signal Corporation was issued the contract in February 1981 and delivery of DBASI (ML-658/GM) instruments to the field should begin in February 1983. Installation will continue through FY 1984. The unit will be solid state, easily transportable, highly accurate, and mercury free. This will eliminate base weather station mercurial barometers and their associated health hazard due to mercury contamination. Funds were approved for FY 1982 to procure replacement temperature/dewpoint and wind measuring equipment and to upgrade cloud-height measuring equipment indicators. A contract was awarded in September 1982 to Tele-Signal Corporation to manufacture the cloud height measuring indicators. A contract for the temperature/dew point equipment should be awarded in late 1982 and the wind equipment in early 1983. Equipment delivery is scheduled for FY 1983 and FY 1984. Funds are programmed in FY 1983 to replace mobile cloud-height measuring equipment and to replace and expand the existing equipment for the worldwide ionosonde network.

A significant improvement in the interaction between forecaster and machine to provide accurate and comprehensive meteorological forecasts is the planned acquisition, beginning in FY 1983, of an Interactive Processing and Display System (IPADS) for use at the AFGWC. In March 1979, a contract was awarded for the acquisition of a Satellite Data Handling System (SDHS) with an option for the acquisition of IPADS. The two complementary systems will provide computer consoles to be used by AFGWC weather technicians to interact directly with the AFGWC computers, thereby eliminating most physical handling of hardcopy information (plotting, overlaying, tracing, posting, sorting, etc.). Meteorological satellite imagery will be electronically integrated with conventional meteorological data to construct weather products.

SPACE ENVIRONMENTAL FORECASTING PROGRAM

Many DOD systems operate in or are affected by conditions above 50 kilometers. The ionosphere, near-space, and deep-space are collectively referred to as the space environment. The AWS provides basic and specialized support to military elctromagnetic comunications, surveillance, and warning systems which operate in or through, or which use the upper atmosphere and nearby space. AWS provides environmental forecasting and specification services in these major technical areas: (1) forecasting and specificataion of ionospheric variability, (2) forecasting and specification of solar flare and solar particle events, and (3) providing geomagnetic and solar indices to users for determining upper atmospheric density variability.

Data Sources

USAF operates and funds for a variety of ground-based and space-based solar-geophysical sensors. The Solar Observing Optical Network (SOON) is comprised of AN/FMQ-7 solar optical telescopes located in Puerto Rico, New Mexico, Hawaii, and Australia. A site is also programmed for the Mediterranean area. The Radio Solar Telescope Network (RSTN) is comprised of four AN/FRR-95 solar radio telescopes; a prototype in Massachusetts, and three others in Hawaii, Australia, and the proposed Mediterranean site. USAF also operates a solar observatory in Greece which makes optical and radio observations using older equipment with limited capability; this operation will be replaced by the Mediterranean observatory.

Geophysical Sensors. USAF operates or funds for the operation of numerous other geophysical sensors as shown in the following table:

Sensor	Purpose	Locations
Polarimeters	Measure total electron content of ionosphere	Nine, N. Hemisphere
Ionosondes	Measure ionospheric electron density profiles	Ten, N. Hemisphere
Magnetometers	Measure changes in geomagnetic field	Five, high latitude
DMSP	Measure precipitating electron flux, ion density, electron/ion temperature, and provide optical auroral pictures	Polar orbit
DOD Spacecraft	Measure high energy and low energy electron/protons	Geostationary orbit

Centralized Operations

AFGWC Space Environmental Support Branch (WSE) provides the only operational space environmental support within the DOD. The support includes the present state and forecasts of the sun, the interplanetary medium, the near-earth space environment, and the ionosphere.

Solar Flares. The Air Force Solar Observing Optical Network (SOON) (An/FMQ-7's) was specifically designed to provide consistent, rapid flare observations and data for reliable short term solar flare forecasting. Currently, the actual work on exploitation of SOON data by applying advanced modeling techniques is being accomplished by the Air Force Geophysical Laboratory and NOAA's Space Environment Laboratory (SEL) located at Boulder, CO.

USAF has four AWS people assigned to the SEL in Boulder. Real-time support has included the production of forecasts and the installation of a computer-to-computer data link system between Boulder and Offutt AFB. This system provides proton and x-ray flux measured by NOAA/GOES satellites; hourly summaries of proton, x-ray, electron, and geomagnetic data; and 90-minute summaries of geomagnetic field variations taken from the Boulder magnetometer. Other real-time support from SEL has been furnished using dedicated communications to relay measurements and assist in the development of joint USAF/NOAA products.

Geomagnetic Index. AFGWC monitors variation of Earth's magnetic field through the use of ground base magnetometers. Information from these sensors is processed at AFGWC to develop a geomagnetic index, A_p, which is transmitted to users for real-time use in density models. Recently, AFGWC has expanded its magnetospheric monitoring by using real-time low energy particle data from operational DOD geostationary spacecraft as well as magnetospheric observations from the GOES satellites.

Ionospheric Variability. AFGWC WSE forecasters monitor the state of the ionosphere, the sun, and the magnetosphere and provide notifications and forecasts of ionospheric irregularities. Short term forecasts for high frequency communications systems can be provided in real-time as can specification and forecasts of electron density profiles and total electron content. Large scale fields of parameters such as FoF_2 are also available.

The primary long-range forecast requirements are for HF radio propagation. AFGWC used the ITS-78 program to provide this support. The program has been modified for direct interface to the Automatic Digital Network, both, for receiving requests and for transmitting its output to worldwide military users.

Event Notification. Since the state-of-the-art in accurately forecasting solar and geophysical events is limited, we have also concentrated on providing rapid notification to system operators of conditions which could degrade the performance of their systems. Rapid event notification is provided for decision assistance to all levels within the military chain of command.

Typical types of notification include: solar events which cause disruption to high frequency communications on sunlit paths; solar radio bursts which may cause disruptions to communications systems and/or interference to radar systems; solar proton events which can produce radiation hazards to both men in space and spacecraft; ionospheric disturbances which can cause degradation to HF and satellite communications systems; and magnetospheric distrubances which affect the orbital parameters of low altitude satellites. AFGWC notifications of these events are usually provided within minutes of detection of a disturbance and are specifically tailored for each system operator.

SUPPORTING RESEARCH

The overall objective of the Air Force meteorological research program is the development of techniques and equipment for observing and predicting meteorological conditions that affect military operations. Requirements for research and technology in meteorology are expressed in Air Force Technology Planning Objectives, Research Objectives, Technology Needs, Statements of Operational Needs, and Development Goals. In addition, the Air Weather Service provides guidance in the form of geophysical requirements and research objectives. The Air Force Geophysics Laboratory (AFGL) at Hanscom AFB, MA, has the mission responsibility within the Air Force to conduct both in-house and contractual basic research and exploratory development in the environmental sciences, including meteorology. Its meteorological program places emphasis on global and mesoscale numerical weather prediction, groundbased and satellite remote sensing, climatological studies, boundary layer meteorology, cloud physics, and battlefield weather measurement and forecasting. Research and development for the Defense Meteorological Satellite Program is also conducted, primarily under contract.

In the area of global numerical weather prediction, an existing spectral model has been modified for use on AFGL computers and on a CRAY-1 supercomputer. Auxiliary computer routines are being developed to emphasize the handling of cloud and moisture in the model. Studies will be undertaken, from both theoretical and experimental bases, to determine the utility of satellite imagery and sounding data in the initialization of NWP models. In mesoscale weather forecasting, satellite and conventional weather data are being incorporated to develop models for the short range (0-6 hours) prediction of cloud ceiling and visibility. Also, a cloud forecast and coastal fog model will be developed for minicomputer application. The coastal fog model is a 2-D numerical/physical model being tested using microphysical fog measurements taken at AFGL's Weather Test Facility at Otis AFB on Cape Cod. The cloud model will focus on lower tropospheric cloud and moisture prediction and will be developed by studying the effects of moisture distribution on the model's time and space scales, in order to define cloud development/dissipation effects. Forecaster effectiveness in an automated operational environment, such as the Automated Weather Distribution System (AWDS), will be evaluated using AFGL's Man-Computer Interactive Data Access System (McIDAS). AFGL will continue to work with NOAA in the evaluation of its Prototype Regional Observing and Forecasting System (PROFS) as intensive mesoscale forecasting experiments are carried out using facilities and data sources tied to an elaborate minicomputer and interactive display system. These experiments will objectively evaluate forecaster performance, system effectiveness, human engineering factors, and dissemination options.

In the ground-based remote sensing area, a carbon dioxide laser-Doppler system will be tested as a means for sensing atmospheric winds, particulary low level wind shear, in the vicinity of air terminals. Automated Doppler weather radar-bafad tecs ni ques will be developed for the detection of meteorological parameters that are precursors to severe storm phenomena such as gust fronts, turbulence, mesocyclones, tornadoes and stratiform winds. There is an urgent need to incorporate these techniques in the joint DOD, DOC and DOT Next Generation Weather Radar (NEXRAD) presently in design evaluation phase. Ground-based passive microwave radiometry techniques will be tested to evaluate their potential in defining zones of aircraft icing potential. Coherent polarization diversity weather radar techniques to derive hydrometeor characteristics such as particle size distribution, orientation and thermo-dynamic phase will be tested. In support of satellite meteorological requirements, improved inversion algorithms will be developed to compute more accurate vertical temperature and water vapor profiles from satellite-measure radiance data at far infrared and microwave wavelengths. Cloud detection algorithms will be developed to distinguish water clouds from ice clouds, cloud-covered areas from clear land, and oceans from snow cover. Also satellite processing techniques to improve the Air Force Global Weather Central's three-dimensional cloud analysis program will be developed.

In climatological technique development, atlases of wind extremes in the upper stratosphere and mesosphere, and of the differences in atmospheric structure between the northern and southern hemispheres between 30 and 100 km, will be developed. Revised models will be developed to provide information on mesoscale variations of ceiling and vertical cloud cover distribution over the globe. An atlas of monthly or seasonal one-minute rainfall rates over land areas of the Northern Hemisphere is under development. In a new effort, weather simulation models are being developed to simulate typical weather sequences for operational applications.

A boundary layer meteorology program is underway in which a series of experimental and theoretical studies will be conducted to define the atmospheric conditions which affect microwave propagation as well as toxic chemical diffusion and transport. A boundary layer prediction model will then be developed. Analytical studies of the effects of snow in the atmosphere on electromagnetic attentuation will also be pursued.

The cloud physics program will place emphasis on the development of smaller, lightweight instruments for deployment on small aircraft and for ground-based measurements. Theoretically-based models of snow growth and size-spectra will be tested and refined. Empirical models to parameterize the microphysical characteristics of cloud and precipiitation system's structure and dynamics will be pursued. The major thrust of the cloud physics program will emphasize the development of computerized mathematical models for forecasting the microphysical structure of clouds and cloud systems, given macroscopic statements about the nature of the atmosphere.

The battlefield weather program will emphasize the development of low-cost, expendable instrumentation for measuring humidity, visibility at visible and infrared wavelengths, and the macroscopic characteristics of clouds and cloud systems (cloud cover amount, cloud tops and bases). Platforms for both unmanned recoverable and expendable alternatives will be investigated, e.g., remotely-piloted vehicles, dropsondes, surface implants and satellites.

DEPARTMENT OF ENERGY

The Department of Energy (DOE) supports meteorlogical services at nine of its laboratories and at the Nevada Test Site. Services include climatological summaries, general weather forecasts, and items specifically in support of laboratory operations such as environmental monitoring, atmospheric sciences research, and hazardous material release assessments. The Weather Service Nuclear Support Office at the Nuclear Test Site provides continuing meteorological services required by the safety and technical programs associated with all forms of nuclear and non-nuclear experiments conducted at the test site and other locations.

DEPARTMENT OF INTERIOR

The principal meteorological activity of the Department of Interior (DOI) is the weather modification research program called Project Skywater, administered by the Bureau of Reclamation, dedicated to augmenting water resources in critical water problem areas of the West through the development and demonstration of a practical precipitation management technology. Other Bureau of Reclamation activities, including runoff forecasting, flood hydrology, irrigation projects, and reservoir operations, as well as projects related to the development of wind and solar energy resources, also require the collection and use of meteorological data.

The Water Resources Division of the Geological Survey collects precipitation and other climatological data for a number of projects concerning rainfall/runoff and other hydrologic processes. Precipitation and dryfall atmospheric deposition samples are collected in a number of studies for the determination of atmospheric contribution to the chemical constituent loads to runoff, and for defining the effect of atmospheric deposition on water quality and the aquatic environment. The Geological Survey provides lead agency coordination for the atmospheric deposition monitoring program of the Interagency Task Force on Acid Precipitation.

The Bureau of Land Management in DOI collects meteorological data from a system of remote automatic weather stations and operates a lightning detection system, containing wideband direction-finders that respond primarily to cloud-to-ground lightning, in its fire-management program.

DEPARTMENT OF STATE

The Department of State interests in meteorology are general but touch a number of areas. They involve the international aspects of food and feeding the world, disaster warnings and assistance, long-range concern with the socio-economic effects of climate change, World Meteorological Organization activities, international meteorological programs, and concern with some programs which start as operating programs but develop international interest and concern such as the possibility of seeding of storms in the Pacific.

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

RESPONSIBILITIES FOR AVIATION WEATHER

The Federal Aviation Administration (FAA) is responsible for the safety and separation of aircraft and the efficiency of flight operations. The adequacy of aviation weather information contributes significantly toward fulfilling these responsibilities. FAA makes recommendations to the U. S. Department of Commerce on civil aviation meteorological services, provides specialized equipment and surface observations at certain airfields, distributes weather data over civil communications systems, and provides the principal means for disseminating weather information to pilots.

Weather information for pilots is made available through Flight Service Stations, recorded messages broadcast over navigational aids, special weather broadcasts, and telephone answering systems. Air Route Traffic Control Centers now have weather service units manned by National Weather Service (NWS) meteorologists to assure that vital weather information is available to the controllers.

FAA maintains a continuing research program to improve aviation weather service to the National Airspace System and its users. FAA also engages in engineering efforts to improve weather observations and communications related to aviation.

The Aviation Weather Program is aimed at progressively improving the timeliness and accuracy of weather information provided to aircrews and to the Air Traffic Control (ATC) system so as to reduce the number of weather related accidents and incidents and to increase both system capacity and fuel savings by reducing weather related delays. Facets of the program are conducted in close cooperation with the National Weather Service (NWS). Wherever practical, the objectives of this program are accomplished by enhancing existing and planned air traffic control and flight service station system components and facilities for the collection, processing, and dissemination of significant weather information.

MAJOR PROGRAMS FOR AVIATION WEATHER

The program encompasses three major development areas: (1) Enhancements to the weather data bases of the air traffic control system to provide pilots and controllers with the capability for rapid access to hazardous and routine weather information; (2) development of an improved national weather radar system for detecting hazardous weather phenomena through the applications of Doppler radar technology; and, (3) development of ground-based automated weather observation systems to provide observations at locations where needed; such as, cost-effective airports with approved instrument approaches. The status and planned accomplishments of specific programs are given below.

Next Generation Weather Radar

The FAA continues to support development of the Next Generation Weather Radar (NEXRAD) with personnel and funding for the NEXRAD Joint System Program Office (JSPO). FAA is participating jointly with the Department of Defense and the Department of Commerce in the development of a common use NEXRAD network to meet the common weather detection requirements of the government and the public. In FY 1982, the initial phase of NEXRAD development began with the award of multiple system definition contracts. In FY 1983, the development of NEXRAD continued with the award of contracts to validate the radar concepts and preliminary designs developed in the preceding system definition phase.

In a NEXRAD-related but independent effort, the FAA will support the testing of optimum weather radar scan rate and signal processing algorithms at the National Severe Storms Laboratory (NSSL) in Norman, OK.

Work on detection, tracking, and 0-30 minute prediction of convective cell movement and intensity will continue in FY 1984. Reflectivity and Doppler radar data collected at NSSL, the FAA Technical Center, and Lincoln Laboratory will provide independent data sets upon which prediction algorithms will be tested for accuracy and reliability.

Center Weather Processor

National Airspace System (NAS) weather related enhancements include implementing in each Air Route Traffic Control Center (ARTCC) and the Central Flow Control Facility (CFCF) the capability for processing, distribution, and display of weather information to pilots, controllers, Flight Service Station Specialists, and meteorologists.

In FY 1983, the specification for the baseline Center Weather Processor (CWP) system was completed. The baseline system includes a computer at each location for data processing and distribution which also supports an automated Center Weather Service Unit (CWSU) work station. The work station will provide the ARTCC and CFCF meteorologists with immediate access to alphanumeric and graphic weather data and products in the computer data base and permit the manipulation of these data/products (contouring, overlay, zoom, scroll, message composition, etc.) to aid in the preparation and dissemination of forecasts to ATC personnel for the area of responsibility. It is planned that procurement actions in FY 1984 will permit field installations of the baseline system in the FY 1987 to FY 1989 time frame. In addition, in FY 1983 work was initiated on the development of interface specifications to permit enhancements of the baseline system to accommodate the distribution of weather information to the pilot through the Mode S data link, the introduction of NEXRAD, and the new ATC systems and software being defined to modernize the ATC complex. This work will continue in FY 1984.

Cockpit Weather Displays

In FY 1981, a breadboard system to provide graphic real-time weather information to the pilot in flight was developed for the FAA by the MITRE Corporation. This weather information is transmitted over the voice channel of the VHF Omnidirectional Range (VOR) stations. In FY 1982, flight tests and evaluations were done to determine the feasibility of this ground based weather radar information being transmitted over the VOR and being utilized by the pilot in flight. Tests conducted in the Ohio area showed that subject pilots had a very favorable response to such a system of weather information when they evaluated it during both simulated and actual weather conditions. Based on these successful studies, the FAA will concentrate efforts during FY 1984 on determining operational guidelines via a pilot factor and safety study, on system requirements via a VOR system study and on a cost/benefit study.

Joint Airport Weather Studies

The FAA, along with the National Science Foundation, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration funded a comprehensive investigation of thunderstorms - the Joint Airport Weather Studies (JAWS) Program - in the Denver, Colorado, area. The program is providing a detailed analysis of thunderstorms in order to develop improved operational procedures for dealing with events hazardous to aircraft operations. These events include wind shear, downbursts, microbursts, hail, heavy rain, turbulence, and lightning. Data were collected from May to August 1982, utilizing Doppler weather radars, surface mesonets, radiosonde soundings, and instrumented aircraft. The data analysis conducted in FY 1983 will continue into FY 1984.

Based on these analyses, FAA will obtain (a) a new technical film on the wind shear hazards, (b) revised siting criteria for the low level wind shear alert system, and (c) data sets on four dimensional wind shear profiles for use in aircraft simulation. In FY 1984, reports will be obtained on (a) life cycle characteristics of thunderstorms, microbursts, and downbursts, (b) siting on Doppler weather radars, and (c) thunderstorm detection by lightning tracking compared to weather radars.

Automation of Weather Observations

Work continues to upgrade the transmissometer/forward-scatter meter. The upgraded visibility measuring equipment will lead to the capability of making visibility observations in Category IIIb weather conditions. Plans were formulated and candidate visibility sensors are scheduled to be installed for operational evaluation. In FY 1983, completion of the Category IIIb tests led to a specification of a system which will be implemented at selected major airports having Category IIIb approved landing aids.

Work continued in FY 1983 to deploy 21, commercially available, trial, automated surface weather observing and reporting systems for an operational test and demonstration at some airports. These system plans are being coordinated with NWS and will give the pilot, via radio, the wind direction and speed, altimeter setting, visibility, ceiling, and temperature. Implementation of approximately 1,100 of these systems is planned to begin in the FY 1984 budget year.

Flight Service Station Automation

The goals of the Flight Service Station (FSS) Modernization Program are to (1) meet the present and projected long-term demand for flight services without a proportional increase in staff and operating cost by providing a national computer-based Flight Service Automation System (FSAS), (2) establish new Flight Service Stations, and (3) ultimately consolidate facilities. Automation will eliminate the manual processing of information by flight service station specialists and provide the means for pilots to obtain weather and aeronautical information directly without the aid of a specialist.

The initial level of automation will be the Model 1 system which will consist of a computer that will be a subset of the final system design for the automated FSSs. Fourteen Model 1 computer systems will be installed at selected Air Route Traffic Control Centers (ARTCCs) which will drive remote alphanumeric terminals at 41 of the busiest FSSs. The Model 1 software will be a relatively simple version that will permit automatic file updating and retrieval, display of alphanumeric weather and aeronautical data, flight plan entry, and flight plan processing. Each computer system will have a dedicated data communications line from the FAA Weather Message Switching Center (WMSC) in Kansas City, MO, and the Automated Service B Data Interchange System (ASBDIS).

The upgraded or Model 2 automation system will provide full specialist automation capabilities. Twenty-three Model 2 computer systems will be installed to replace the Model 1 computer systems and drive the remoted specialist terminals at the 61 FSSs to be automated. The specialist terminals will display alphanumeric and graphic data to be furnished directly by two Aviation Weather Processors (AWPs). One AWP will be located at Salt Lake City, UT, and the other, at Atlanta, GA. The AWPs will interface with the WMSC for alphanumeric data and with NWS's National Distribution Circuit (NDC) for graphic weather products. Weather radar data will be received from selected NWS/FAA radars and stored in each computer system for instant retrieval. This will provide the necessary automation capacity to meet forecast service demands through 1995 for FSS specialist operating positions and for self-briefing access features for pilots throughout the country. Details are given in the Master Plan for Flight Service Station Automation Program, January 1978, and the Master Plan Addendum, March 1980.

Phase I of the FSS Automation Program was completed in FY 1981. A single contractor was selected to accomplish Phase II of the program which provides for the production/installation of the Models 1 and 2 computer systems, two AWPs and the development of long-term enhancements to the Model 2 system. In FY 1984, an engineering contract will be awarded for Model 2 system enhancements including a Package 1 - Voice Response System (VRS) and interfaces for user owned commercially available self-briefing terminals. In addition, Automated Route Forecast and Local Area Weather Briefing features will be added to the system.

In FY 1983, five Model 1 computer systems are planned and 12 FSSs will receive remote alphanumeric terminals. Other major efforts in the FSS program are to develop techniques that will permit pilots to have direct access to the FSS automation data base. The approach is as follows:

- Continue development of computer-generated Voice Response System (VRS) capability. Provide operational tests in the Washington, D.C., and Columbus, OH, areas.
- Develop automated flight plan filing capability via telephone with touchtone.

- Integrate voice response/flight and Pilot Automatic Telephone Weather Service (PATWAS) into a national system designed for pilot self-briefing.
- Develop the concept of pilot self-briefing via interactive coupling of user-owned terminals with the FSS automation data base.
- Jointly develop, with NWS, new formats and techniques for generating, processing, and delivering aviation weather products to pilots for preflight and inflight applications.

Prototype Regional Observing and Forecasting Service (PROFS) Program Support

In FY 1983, the FAA supported PROFS Program operated by NOAA to supply the Denver ARTCC CWSU with enhanced product data and forecasts that, (a) reduced air traffic delays at the Denver Stapleton airport, and (b) provided algorithmms and computer programs for integration into CWP/CWSU development. Mesometeorological network data sets, visible and IR satellite data, and Doppler weather radar data were integrated into a variety of new products and transmitted to the CWSU meteorologists at the Longmont (Denver) ARTCC.

CWSU meteorologists were given short-term forecasts of airport wind shifts, severe thunderstorms, orographic turbulence, and the occurrence of low clouds and visibilities.

In FY 1984, the evaluations will be continued and enhanced modes of evaluation of weather situations will be incorporated in future CWP developments.

Low Level Wind Shear

There are currently 59 low-level wind shear alert systems, installed at U. S. airports. In FY 1983, a contract was awarded for an additioinal 51 systems. Installation of these systems will begin in FY 1984 and be completed in FY 1985. This system uses wind sensors (anemometers) around the airport, usually near the approach and departure ends of the runways, and compares the readings from these sensors with a centerfield wind sensor. When a wind shear is apparent from this comparison, the tower controller is alerted and the information is passed from the controller to the pilot approaching the airport or preparing for takeoff.

U.S. COAST GUARD

The U.S. Coast Guard is authorized by 14 USC 147 to cooperate with the National Oceanic and Atmospheric Administration (NOAA) in the observation and dissemination of weather information.

As part of its mission to support the Nation's weather program, the Coast Guard cooperates with the National Weather Service (NWS) in the collection of synoptic and other regularly scheduled observations from cutters and shore installations. Raw weather observations are transmitted via Coast Guard communications facilities to National Weather Service (NWS) forecast offices. Coast Guard communications stations also relay meteorological reports from coastal and high seas shipping to the NWS. These data are utilized by the NWS in producing their forecasts, which are then disseminated in part by the Coast Guard over Coast Guard radio facilities as part of the Marine Information Broadcasts. Additionally, data link and logistics support is provided for NWS automated sensors placed at Coast Guard stations.

Coast Guard personnel stationed at the NOAA Data Buoy Office (NDBO) at Bay St. Louis, MS, furnish technical support and liaison for the NOAA Data Buoy Project. Coast Guard vessels are employed to position, deploy and maintain NDBO environmental buoys, and communications facilities provide data relay functions.

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for working with state and local government agencies to ensure adequate air quality meteorological support programs. Applied research and operational meteorological support to EPA is provided by the Meteorology Division of Environmental Science Research, Research Triangle Park, NC, Laboratory of NOAA's Air Resources Laboratories. Such operational support to the Office of Air, Noise, and Radiation, the EPA Regional Offices, and other EPA components includes review of the meteorological aspects of environmental impact statements, state implementation plans, application of dispersion models, and preparation of dispersion studies and evaluations.

RESEARCH PROGRAM FOR FISCAL YEAR 1984

EPA applied research is in the areas of air quality dispersion model development, evaluation, verification, and application, development and application of air pollution climatology, determination and description of pollutant effects on atmospheric parameters, and determination of meteorological effects on air quality. Dispersion models for inert and reactive pollutants are under development and evaluation on all temporal and spatial scales; e.g., urban and regional. Particular emphasis is being given to the development of a dispersion model for use in complex terrain; and photochemical air quality dispersion models on several scales utilizing data collected during earlier field programs. The data obtained from the field programs initiated in FY 1983-1984 will be used to develop and evaluate models in the FY 1983 period. Planetary and urban boundary layer models are under development for use with air quality dispersion models. Examination of the relationship between meteorology and air quality continues with emphasis on ozone, sulfates, and other particulate matter. The effects of air pollutants on atmospheric parameters, such as visibility and acidic precipitation chemistry, are also under continuing investigation.

INTERAGENCY FUND TRANSFERS

Funds are transferred to the National Oceanic and Atmospheric Administration for the provision of meteorological research and operational support of the agency's regulatory mission. Research activities define, describe and study the meteorological factors important to air pollution regulatory activities and the development of air quality standards and criteria. Air quality models are developed, evaluated, and validated for use by EPA in its regulatory and compliance activities. A users network for applied models of air pollution (UNAMAP), consisting of dispersion models either developed internally or by other groups and validated under the program, is maintained and continuously modified and expanded for use by the public and private sector. Direct operational support includes the review of the meteorological aspects of environmental impact statements, state implementation plans, and other compliance documentation; the application of dispersion models for control strategy evaluation; and the conduct of physical and mathematical dispersion studies for guideline and standard development, evaluation, and implementation.

FEDERAL EMERGENCY MANAGEMENT AGENCY

The Federal Emergency Management Agency (FEMA) was established in 1979, to merge closely allied Federal programs involved with preparedness, mitigation, response, and recovery to national emergencies ranging from natural and man-made hazards to nuclear attack. FEMA replaced five former agencies, consolidating into a single organization a dozen different Federal emergency-related activities, including such functions as community-awareness for meteorological emergencies emergencies and coordination of all emergency warnings.

One example of a FEMA activity that is directly related to meteorology is the hurricane preparedness program which funds local vulnerability and evacuation studies. Additional meteorologically related programs, within the Office of Natural and Technological Hazards, deal with flooding, dam safety, atmospheric releases of hazardous and radiological materials, and other meteorological hazards. Although FEMA has only one full-time meteorologist, the Agency has called upon the Department of Commerce and other agencies for support during times of emergencies.

Within FEMA, the Office of Research serves as principal point of contact for technological studies and coordination. No specifically meteorological studies are funded in FY 1983, but a close watch is kept on selected programs of other agencies, including the Department of Defense.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The National Aeronautics and Space Administration (NASA) Atmospheric Sciences Research Program conducts research using space technology to improve our understanding of atmospheric behavior on scales ranging from the mesoscale to the planetary scale and from periods of hours to decades. NASA's role in this endeavor is based upon the unique perspective of the earth's atmosphere and surface provided by space platforms. Satellite sensors can and do provide not only global coverage, but obtain repetitive observations of limited areas more cost-effectively than by any other means. Space observations can and do provide information essential to advancing our knowledge of atmospheric processes.

The NASA program includes the following major components:

- Development of space-borne observing systems and supporting ground-based systems which monitor and detect severe weather phenomena and the antecedant conditions.
- Development of algorithms and inversion techniques to derive useful atmospheric parameters from remote sensor data.
- Development of data processing and data assimilation techniques to address the problems peculiar to the use of satellite data.
- Analysis of satellite data to advance understanding of atmospheric behavior.
- Development of models which can exploit the spatial densities and temporal frequencies inherent in satellite data to initialize and verify models and assess their value.
- Development of parameterization schemes which serve as the basis for the use of space observations in atmospheric models of all scales.
- Assessment of the performance of satellite sensors through numerical experiments which compare model output with and without satellite data.

In studying mesoscale phenomena, NASA uses geosynchronous satellite data (especially NASA-developed temperature soundings) aircraft instrumentation (e.g., Doppler lidar wind measurements) and ground based techniques in addition to conventional observations to obtain data that will improve our understanding of the processes involved in their generation, propagation and decay. Models are being developed to use the quantitative information provided by the geosynchronous sounders.

NASA research on defining the temporal and spatial variability of lightning continues. The work is intended to provide some understanding of the range of phenomena from global electrical behavior to the relationship with storm severity and tornado occurrence. A limited climatology of lightning strike points has already been derived from Department of Defense satellite data, and techniques to observe the majority of discharges, day or night, from geosynchronous orbit are being investigated.

As part of a joint NASA/NOAA project called the Centralized Storm Information System (CSIS), a computer-based image display system has been installed at the National Severe Storms Forecast Center in Kansas City, MO. The system, which locates, rectifies, scales and displays a wide variety of meteorological information including satellite images, radar plots, synoptic analyses and upper air data on video consoles has been well received by the forecasters. The installation and shakedown phases of this project have been completed. NASA has fulfilled its objectives in technology transfer by collaborating with NOAA to install the system and NOAA will continue to utilize and evaluate the system.

NASA has been assigned lead responsibility for the National Climate Program's principal thrust in Solar and Earth radiation. The Earth's radiation budget, which is the central element of this research, describes the energy balance which exists between the Sun, Earth, and space. It is the geographical and temporal imbalance in this key relationship which governs the state and changes of regional climate. Earth radiation budget data acquired by Nimbus research satellites, beginning in 1976, are currently being processed and merged into a global climate data set, to be augmented with data from the Earth Radiation Budget Experiment (ERBE) beginning in 1984. Monitoring of the solar irradiance is also being accomplished by sensors aboard Nimbus 7 and the Solar Maximum Mission (SMM). The total solar irradiance (often referred to as the solar constant) is the basic source of energy for driving the climate system. Climate model studies have shown that persistent variability in this quantity could have a major impact on climate.

As part of its climate research activity, NASA is participating in the World Meteorological Organization sponsored International Satellite Cloud Climatology project which will use both geosynchronous and low orbiting satellites beginning in 1983 to collect a five-year data set for analysis and use in earth radiation budget studies. The cloud climatology, when developed, will be the most complete ever assembled.

NASA continues to supply NOAA with the TIROS-N and GOES series spacecraft (funded by NOAA) for operational meteorological deployment.

The data set gathered during the GARP Global Weather Experiment serves as the basis for analyses under NASA research proposals. Emphasis is placed on observations obtained from space with the interpretation and application of these data to the development of advanced techniques for modeling and prediction. Nearly one hundred investigations, proposed by both NASA scientists and those from the external scientific community, involve the analysis, diagnosis, modeling and evaluation studies using these data.

An advanced computer system, using a Cyber 205, was delivered to the Goddard Space Flight Center during the fourth quarter of FY 1982. This computer will increase the present NASA computing capability used for atmospheric research by a factor of ten in order to accommodate the growing requirements for data analysis and modeling with satellite data in the atmospheric, oceanic and earth sciences.

NASA continues to support research and development activities to improve our remote sensing capabilities for possible future deployment on satellites. Studies involve remote sensing of atmospheric temperature, pressure, moisture, and winds using passive and active techniques. Having analyzed the data from the successful flights of an airborne Doppler lidar wind measuring system during the summer of 1981, a new series of field experiments is planned for FY 1984 to explore additional mesoscale phenomena in detail.

NUCLEAR REGULATORY COMMISSION

The Nuclear Regulatory Commission (NRC) licenses and regulates all nuclear facilities subject to the Atomic Energy Act of 1954, as amended. The licensing and operation of nuclear facilities require identification and evaluation of meteorological conditions that can affect the safe operation of the facility and that provide input to the assessment of the radiological impacts of any airborne releases from the facility.

Within the NRC, the Offices of Nuclear Reactor Regulation and Nuclear Material Safety and Safeguards review facility siting, design, construction, and operation. These reviews include consideration of meteorological factors. The Office of Inspection and Enforcement and the regional offices assure that commitments by NRC applicants, permittees and licensees are carried out and conduct NRC response to nuclear facility emergencies. The Office of Nuclear Regulatory Research develops regulations, guides, criteria, and other standards relating to the protection of public health and safety and the environment in the licensing of nuclear facilities. This Office also develops and conducts confirmatory research programs in support of activities of the other offices and in support of rule-making and standards activities.

There are several meteorological areas which have a major emphasis during FY 1983 and beyond and may involve the cooperative efforts of all of the NRC offices. Paleoclimatic site investigations of high-level radioactive waste depositories are being conducted, and meteorological criteria for siting of low-level radioactive waste depositories are being developed. Upgrading of the meteorological capabilities of the NRC and the operators of nuclear facilities are in process to cope with emergencies involving unplanned airborne releases of radioactive material from the facility. These meteorological capabilities include upgrading of meteorological programs at nuclear facility sites, development of assessment capabilities, and meteorological data and analysis transmission capabilities in real-time. Regulatory guides are being revised or are under development for nuclear facility design with respect to extreme meteorological events such as tornadoes, severe dust storms, lightning, extreme winds and temperatures, and snowloads. Updated guidance on meteorological measurement programs is being developed. Major research efforts include dispersion model evaluation and analyses of data from NRC-sponsored dispersion tests.

APPENDIX B

ACRONYMS AND ABBREVIATIONS

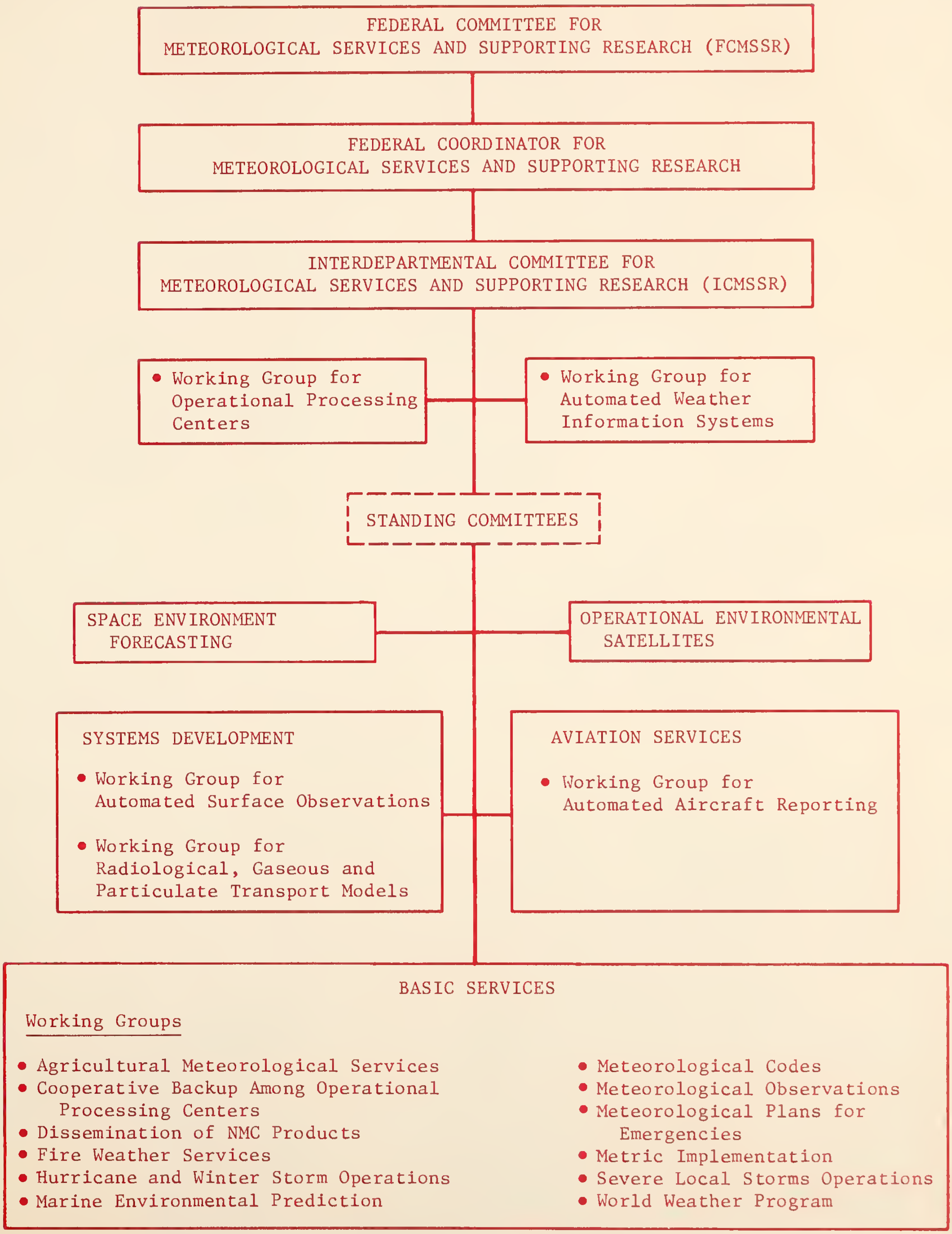
AAR	Automated Aircraft Reporting
ADDS	Atmospheric Distributed Data System
ADWS	Automated Digital Weather Switch
AEPS	Automated Environmental Prediction System
AEW	Airborne Early Warning
AF	Air Force (USAF)
AFB	Air Force Base
AFCC	Air Force Communications Command
AFGL	Air Force Geophysical Laboratory
AFGWC	Air Force Global Weather Central
AFOS	Automation of Field Operations and Services
AFRES	Air Force Reserve
AHOS	Automated Hydrologic Observing System
AID	Agency for International Development
AMR	Aircraft Microwave Refractometer
APT	Automatic Picture Transmission
ARGOS	French Data Collection System
ARRS	Aerospace Rescue and Recovery Service
ARTCC	Air Route Traffic Control Center
ASDAR	Aircraft to Satellite Data Relay
ASW	Anti-Submarine Warfare
ATC	Air Traffic Control
AVHRR	Advanced Very High Resolution Radiometer
AWDS	Automated Weather Distribution System
AWIS	Automated Weather Information Systems
AWOS	Automated Weather Observing System
AWN	Automated Weather Network
AWR	Advanced Weather Radar
AWS	Air Weather Service
AWSC	Agricultural Weather Service Center
CAC	Climate Analysis Center
CAD	Consortium on ASDAR Development
CARCAH	Chief Aerial Reconnaissance Coordination, All Hurricanes
CAS	Committee for Aviation Services
CAT	Clear Air Turbulence
CBS	Committee for Basic Services
CDA	Command and Data Acquisition
CDAS	Command and Data Acquisition Station
CDDF	Central Data Distribution Facility
CEAS	Center for Environmental Assessment Services
COES	Committee for Operational Environmental Satellites
COMEDS	Continental U.S. Meteorological Data System
COMNAVOCEANCOM	Commander Naval Oceanography Command
CONUS	Continental United States
CPU	Centralized Production Unit (USAF)
CSD	Committee for Systems Development
CSEF	Committee for Space Environment Forecasting
CWSU	Center Weather Service Unit (FAA)

DACS	Data Acquisition and Control Subsystem
DCPLS	Data Collection and Platform Location System
DCS	Data Collection System
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DOS	Department of State
DOT	Department of Transportation
DPSS	Data Processing and Services Subsystem
E/O	Electro-Optical
EPA	Environmental Protection Agency
ERBE	Earth Radiation Budget Experiment
ERBSS	Earth Radiation Budget Satellite System
ERL	Environmental Research Laboratories
ESSC	Environmental Studies Service Center
FAA	Federal Aviation Administration
FCMSSR	Federal Committee for Meteorological Services and Supporting Research
FEMA	Federal Emergency Management Agency
FLENUMOCEANCEN	Fleet Numerical Oceanography Center
FNOC	Fleet Numerical Oceanography Center
FSAS	Flight Service Automation System
FSS	Flight Service Station
FY	Fiscal Year
GAO	General Accounting Office
GARP	Global Atmospheric Research Program
GDPS	Global Data Processing System
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
GOS	Global Observing System
GTS	Global Telecommunications System
GWE	Global Weather Experiment
HIRS/2	Modified High Resolution Infrared Sounder
HRPT	High Resolution Picture Transmission
ICMSSR	Interdepartmental Committee for Meteorological Services and Supporting Research
ICSU	International Council of Scientific Unions
IPADS	Interactive Processing and Display System
IR	Infrared
ITOS	Improved TIROS Operational Satellite
JAWOS	Joint Automated Weather Observing System
JAWS	Joint Airport Weather Studies
JSPO	Joint System Program Office (NEXRAD)
KM (or km)	Kilometer

M	Million
MAC	Military Airlift Command
McIDAS	Man-computer Interactive Data Access System
MMS	Meteorological Measuring System
MOS	Model Output Statistics
MSU	Microwave Sounding Unit
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communication Center
NAVEASTOCEANCEN	Naval Oceanography Center, Norfolk, VA
NAVOCEANCOMCEN	Naval Oceanography Command Center
NAVOCEANCOMDET	Naval Oceanography Command Detachment
NAVOCEANCOMFAC	Naval Oceanography Command Facility
NAVOCEANO	Naval Oceanographic Office
NAVPOLAROCEANCEN	Naval Polar Ooceanography Center, Suitland, MD
NAVWESTOCEANCEN	Naval Western Oceanography Center, Pearl Harbor, HI
NAWAS	National Warning System
NCC	National Climatic Center
NCP	National Climate Program
NCPO	National Climate Program Office
NDBO	NOAA Data Buoy Office
NDC	National Distribution Circuit
NEDN	Naval Environmental Data Network
NEDS	Naval Environmental Display Station
NESDIS	National Environmental Satellite, Data and Information Service
NEXRAD	Next Generation Weather Radar
NHC	National Hurricane Center
NHELTR	National High Energy Laser Test Range
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NOMSS	Naval Oceanographic and Meteorological Support System
NOTAM	Military Notice to Airmen
NRC	Nuclear Regulatory Commission
NSF	National Science Foundation
NSSFC	National Severe Storms Forecast Center
NSSL	National Severe Storms Laboratory
NTSB	National Transportation Safety Board
NWR	NOAA Weather Radio
NWS	National Weather Service
OFCM	Office of the Federal Coordinator for Meteorology
OMB	Office of Management and Budget
OPARS	Optimum Path Aircraft Routing System
OWRM	Office of Weather Research and Modification
P-3	Four Engine Transport (Lockheed Orion)
PATWAS	Pilot Automatic Weather Answering Service
PROFS	Prototype Regional Observing and Forecasting System
R&D	Research and Development
RD/T&E	Research and Development, Test/Evaluation
RFC	River Forecast Center
RFP	Request for Proposal

RMC	Regional Meteorological Center(s)
ROMS	Remote Ocean Surface Measuring System
SATCOM	Satellite Communications System
SBUV	Solar Backscatter Ultraviolet Instrument
SCM	System Control and Monitor
SDHS	Satellite Data Handling System
SEL	Space Environment Laboratory
SEM	Space Environment Monitor
SFSS	Satellite Field Services Station
SMCC	Systems Monitoring and Coordination Center
SMS	Synchronous Meteorological Satellite
SOCC	Satellite Operations Control Center
SPC	U.S. Navy Satellite Data Processing Center
SSU	Stratospheric Sounding Unit
TESS	Tactical Environmental Support System
TFU	Tactical Forecast Unit
TIROS	Television Infrared Observation Satellite
TOVS	TIROS N Operational Vertical Sounder
UN	United Nations
USAF	United States Air Force
USAFETAC	USAF Environmental Technical Applications Center
USC	United States Code
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture
USN	U.S. Navy
UV	Ultraviolet
VAS	VISSR Atmospheric Sounder
VCP	Voluntary Co-operation Program
VHF	Very High Frequency
VHRR	Very High Resolution Radiometer
VISSR	Visible and Infrared Spin Scan Radiometer
VRS	Voice Response System
VTPR	Vertical Temperature Profile Radiometer
WCRP	World Climate Research Program
WEFAX	Weather Facsimile
WFSC	Weather Facsimile Switching Center
WMC	World Meteorological Center(s)
WMO	World Meteorological Organization
WMSC	Weather Message Switching Center
WSCMO	Weather Service Contract Meteorological Office
WSFO	Weather Service Forecast Office
WSMO	Weather Service Meteorological Office
WSO	Weather Service Office
WWB	World Weather Building
WWP	World Weather Program
WWW	World Weather Watch

*U.S. GOVERNMENT PRINTING OFFICE :1983 0-380-997/847


FEDERAL COMMITTEE FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (FCMSSR)
FEDERAL COORDINATOR FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH
INTERDEPARTMENTAL COMMITTEE FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (ICMSSR)
• Working Group for Operational Processing Centers
• Working Group for Automated Weather Information Systems
STANDING COMMITTEES
SPACE ENVIRONMENT FORECASTING
OPERATIONAL ENVIRONMENTAL SATELLITES
SYSTEMS DEVELOPMENT
• Working Group for Automated Surface Observations
• Working Group for Radiological, Gaseous and Particulate Transport Models
AVIATION SERVICES
• Working Group for Automated Aircraft Reporting
BASIC SERVICES
Working Groups
• Agricultural Meteorological Services
• Cooperative Backup Among Operational Processing Centers
• Dissemination of NMC Products
• Fire Weather Services
• Hurricane and Winter Storm Operations
• Marine Environmental Prediction
• Meteorological Codes
• Meteorological Observations
• Meteorological Plans for Emergencies
• Metric Implementation
• Severe Local Storms Operations
• World Weather Program

Effective February 23, 1983

A000012526406